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Before the
Montana Board of
Natural Resources
and Conservation
in the matter of
water reservation
application nos.

BEFORE THE MONTANA BOARD OF NATURAL RESOURCES AND CONSERVATION

* *

IN THE MATTER OF WATER)
RESERVATION APPLICATION NOS.)
69903-41O 71895-41I 72578-41L)
70115-41F 71966-41S 71579-41T)
70117-41H 71997-41J 72580-41A)
70118-41H 71998-41S 72581-41I)
70119-41H 72153-41P 72582-41I)
70270-41B 72154-41K 72583-41P)
71537-41P 72155-41A 72584-41S)
71688-41L 72256-41P 72585-41M)
71889-41Q 72307-41Q 72586-41P)
71890-41K 72574-41O 72587-41G)
71891-41P 72575-41K 72588-40C)
71892-41G 72576-40E 73198-41I)
71893-41K 72577-41P 73199-41S)
71894-41I IN THE UPPER)
MISSOURI RIVER BASIN)

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DEPARTMENT OF FISH, WILDLIFE AND PARKS' PREFILED DIRECT TESTIMONY

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Prefiled direct testimony submitted in support of the Department of Fish, Wildlife and Parks' application for instream flow reservations in the upper Missouri River Basin

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November 1, 1991

Volume 2

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BEFORE THE MONTANA BOARD OF NATURAL RESOURCES AND CONSERVATION

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IN THE MATTER OF WATER)
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November 1, 1991

Volume 2

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LIST OF WITNESSES FOR THE DEPARTMENT OF FISH, WILDLIFE AND PARKS PREFILED DIRECT TESTIMONY

Volumne 1

Patrick Graham

Liter Spence

Charles Parrett

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Steve Leathe

Ken Frazer

Rod Berg

Dan Hook

Wade Fredenberg

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Mike Poore

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Ron Spoon

Al Wipperman

Gary Olson

Bill Gardner

Bill Hill

Daniel Casey

Ken Knudson

Joe Eilliot

John Duffield

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PRE-FILED DIRECT TESTIMONY OF RONALD L. SPOON ON BEHALF OF THE MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. Please state your name and business address.

A. Ron Spoon, MDFWP, P.O. Box 1137, Townsend, MT 59644.

Q. What is your present employment?

A. I am a fisheries biologist employed by the Montana Department of Fish, Wildlife and Parks.

Q. Please state your educational background and experience.

A. I was educated in Montana public schools through high school. I am a 1980 graduate of the University of Montana with a B.S. in Wildlife Biology, Aquatic Option. I received a M.S. in Fish and Wildlife Management at Montana State University in 1985. I have been employed with MDFWP from 1979 to the present time, except for a three year period when I attended graduate school (1981-84).

Q. What experience do you have that qualifies you to address the issue of reserving streamflows for fisheries?

A. Of the 12 years that I have worked with fisheries in Montana, seven years involved addressing the impacts that dewatering has on a variety of Montana trout fisheries. This work took place in the Bitterroot, Clark Fork, and Missouri River drainages. In the Bitterroot River, I evaluated the potential fisheries benefits from releasing supplemental water from Painted Rocks Reservoir. The Clark Fork River fisheries study involved determining the relative impacts of pollution from mining wastes and dewatering in the system. I also participated in a study on the Missouri River below Hauser Dam to evaluate potential impacts on the trout fishery of altering the flow regime of a hydroelectric facility. In the course of these studies, I have become well acquainted with the relationship between stream flows and fisheries.

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to describe the fishery of the Missouri River between Hauser Dam and Holter Lake to illustrate the importance of this fishery. I will also demonstrate the need for maintaining suitable stream flows in this reach to protect crucial spawning and rearing habitats of salmonid populations in the Missouri River and Holter Reservoir.

Q. What portion of the Department's application covers material

that is supported by your testimony?

A. My testimony relates to the fisheries within in a 3.5 mile segment of Reach #2, located between Hauser Dam and Holter Reservoir as described in Volume 3, pages 3-6 through 3-12 of the application. A map showing the location of this stream reach is contained in Appendix A of this testimony.

Q. Have you participated in fisheries studies in the Missouri River drainage that relate to this flow reservation?

A. Yes. For three years (1981 to 1984) I worked exclusively on the fishery within the short segment of river between Hauser Dam and Holter Reservoir. At this time, I was a graduate student with the Cooperative Fisheries Research Unit, located at Montana State University. Myself, another graduate student, and a fisheries biologist working for the Cooperative Fisheries Research Unit conducted the study under the supervision of Dr. Robert G. White, leader of the Cooperative Fisheries Research Unit. My role in the study was to determine flow releases needed to maintain adequate spawning and egg incubation success in the Missouri River below Hauser Dam. I also assisted with all other phases of the study, which included assessments of trout fry rearing requirements, and monitoring of adult population trends. Since I was a part of the study team, I am thoroughly knowledgable about the data collected and conclusions made from all phases of the study. Montana Power Company and Department of Fish, Wildlife and Parks personnel also assisted with various phases of this work.

Although graduate student research is typically focused on specific fisheries issues, I believe it is uncommon for three researchers to spend 3-years in such a limited study area. The large amount of effort expended to determine the relationship between flow releases and fishery requirements reflects the importance of this fishery.

Q. What was the purpose of this study?

A. The primary purpose of this study was to determine the potential impacts of altering the flow release pattern from Hauser Dam on fish populations in the Missouri River. This study was sponsored by the Montana Power Company, which owns and operates Hauser Dam.

Q. Besides studying the fishery, did this work involve stream flow assessments that can be applied to the instream flow reservation process?

A. Yes. In fact, the primary emphasis of this study was to determine stream flow requirements of various life history

stages of trout residing below Hauser Dam. Not only were data collected on fisheries and flow releases, but these data were meshed together to determine how various flow regimes might influence the trout fishery at various times of the year.

Q. Given the work you have described, how would you rate the current understanding of flow needs in this reach of the Missouri River?

A. Because of the extensive research conducted in this short river segment, I believe we have obtained a thorough understanding of the flow needs below Hauser Dam. This work employed some of the same methods used throughout the Missouri River basin in the Department's instream flow reservation analysis. The primary difference in our work is that more manpower was available to make field observations that were used to develop biological-flow relationships, which require considerable time and effort.

Q. Please describe the fishery of the Missouri River downstream of Hauser Dam?

A. It is one of the best trout fisheries in Montana during periods when spawning fish migrate from Holter Reservoir to spawn in the short reach of flowing river below Hauser Dam. Fall population estimates for brown and rainbow trout have been conducted annually since 1982 with the exception of 1984 when no estimate was conducted. These estimates show exceptional rainbow trout densities (3,000 to 6,000 rainbow trout per mile in the last 5-years). Although brown trout densities are lower (200 to 500 brown trout per mile), the stream is particularly noted for producing trophy brown trout during the fall spawning period. Brown trout weighing from 5 to 12 pounds are caught by anglers. In recent years, kokanee have become an important component of the fishery. Like brown trout, kokanee primarily reside in Holter Reservoir and use the flowing segment of river below Hauser Dam for spawning. The increase in the kokanee population appears to have impacted the brown trout population, but this event does not lessen the need for desirable flow releases to maintain brown trout spawning and rearing success.

Q. Is this a popular fishery?

A. It is very popular. Based on creel census data obtained by MDFWP during portions of 1982, 1983, and 1985 in the Missouri River below Hauser Dam, there is considerable fishing pressure in this short segment of river. During October, when brown trout spawners are concentrated below Hauser Dam, angler use estimates ranged from 810 to 1,049 angler-days in 1982, 1983, and 1985. During 1983, an estimated 8,719 angler-days were expended on the river between March 1 and November 30. This

information is based on 3,662 actual interviews with anglers.

Q. How does the fishery in this short segment of flowing river relate to the fishery in Holter Reservoir?

A. The Missouri River below Hauser Dam represents the primary spawning area for brown trout, rainbow trout, and kokanee residing in Holter Reservoir. Consequently, juvenile fish produced in the river contribute to the fisheries of the river and the reservoir.

Q. Is there a large amount of habitat below Hauser Dam that is suitable for spawning and production of young fish?

A. No. The availability of quality spawning habitat is confined to four relatively small areas below the dam. Spawning nests (redds) are very concentrated in these areas. Our observations that redds constructed by differnt spawning fish are superimposed upon each other indicates there is limited area available for successful spawning and reproduction.

Q. Does this mean that spawning habitat is the limiting factor for trout populations in this system?

A. Since brown trout are entirely self-sustaining, I believe it does mean that spawning habitat and successful reproduction appears to limit the size of the brown trout population. This may also be true for kokanee but we have less data on this species which is relatively new to the system. Rainbow trout are stocked in both Hauser and Holter reservoirs each year. Therefore, the rainbow trout population in the river below Hauser Dam is composed of both wild and hatchery fish and is not entirely self-sustaining.

Q. Why is the Department concerned about natural reproduction of brown trout and other species which occur in Reach #2?

A. The past and current brown trout and kokanee fisheries have been sustained by natural reproduction. These "wild" fisheries have produced fish that are well adapted to their environment, and have proven capable of producing desirable fisheries for anglers. Our Department believes it is important to maintain the attributes of trout species which have developed via natural reproduction in stream and lake systems. In addition, introductions of hatchery trout have been shown to have detrimental effects on existing, wild fisheries in other areas of Montana. Therefore, I believe it is important to maintain at least current levels of natural reproduction in the system.

Q. Is successful reproduction in this reach influenced by the flow regime below Hauser Dam?

information is based

Q. How does this

A. The

Q.

A.

A. Successful spawning and reproduction is very much a function of the flow pattern of the river. The amount of available spawning habitat changes as flows change, and once spawning has occurred, it is critical to maintain adequate flows to ensure that incubating eggs remain adequately covered with water.

Q. Are instream flows necessary for this reach of the river?

A. Yes. Our work shows that adequate flows for spawning and incubation are needed to provide successful reproduction to maintain the existing fishery. We developed seasonal flow recommendations to facilitate spawning and rearing requirements for both brown and rainbow trout.

Q. What methods were used to derive the flow requests?

A. We used biological-flow relationships to recommend flow releases to the Montana Power Company during the critical spawning and incubation periods for brown and rainbow trout. Since spawning and reproduction appeared to limit the size of the adult population, the biological-flow relationships were primarily based on how changes in the flow pattern would impact reproductive success of brown and rainbow trout. The primary information needed to determine the biological-flow relationship was: 1) Physical and hydraulic characteristics of the spawning sites; 2) Hydraulic modeling to determine how the spawning sites would be affected at various flow levels. Examples of how this information is applied are shown in Appendix B. These examples demonstrate how the amount of spawning habitat that will be covered with water is related to three streamflow levels.

During the period when trout spawning and incubation of eggs were not a consideration (July 1-October 14), the study conducted for the Montana Power Company did not specify flow releases for protection of the fishery. For the purposes of the Missouri River instream flow application, however, wetted perimeter data collected during the study is being used to request instream flows for the summer period.

Q. Is the information contained in this portion of the Department's application relevant and accurate?

A. Yes. The only change that has occurred since the study was completed in 1984 is the decline of the brown trout fishery and the expansion of the kokanee fishery. However, this occurrence does not change the recommended flow pattern below Hauser Dam.

Q. Did you use any other instream flow methods in your study?

A. Yes. In addition to biological-flow relationship data and wetted perimeter data, we also collected physical habitat simulation (PHABSIM) data. This modeling method is a subroutine of the Instream Flow Incremental Methodology (IFIM) developed by the U.S. Fish and Wildlife Service.

Q. Why were the wetted perimeter and IFIM methods not used in your seasonal flow recommendations to the Montana Power Company?

A. Wetted Perimeter: Based on our field observations, the upper inflection point of the wetted perimeter curve (3,500 cfs), did not provide sufficient flows over the available spawning gravels for brown trout or rainbow trout to use.
Physical Habitat Simulation: We initially intended to predict flow-related impacts on spawning and egg incubation by using habitat modeling (PHABSIM) results, but reliability of these results was seriously questioned. For this model to provide realistic predictions, the inputs to the model (water depth, velocity, and substrate size) must accurately identify the available spawning habitat. However, observed spawning activity was concentrated in a few small, isolated areas and did not occur throughout most of the habitat that the model predicted to be available. We, therefore, chose an alternative to habitat modeling that did not involve speculation about available spawning habitat. Our approach was to observe the actual spawning locations and assess how those areas would be impacted at specific flows by using predictive hydraulic modeling. This method effectively removed potentially erroneous assumptions and relied on actual data.

Q. On your maps in Appendix B you illustrate spawning areas in relation to three flow levels. Why wouldn't spawning fish just move to other areas further out in the river at flows lower than 1,358 cfs?

A. Trout select spawning areas within a relatively narrow range of water depth, velocity, and gravel size. There are also other factors involved in spawning site selection such as groundwater upwelling and contour of the stream bottom. These factors are difficult to measure, which is part of the reason that modeling inputs rely on assumptions. Gravel availability is particularly important below Hauser Dam because the dam blocks the delivery of new gravels to potential spawning areas. Thus, the high-quality spawning gravels that have persisted in the river channel are generally located in relatively shallow areas. Only a very limited amount of suitable spawning gravel would be associated with adequate water depth and velocity at a flow of 1,358 cfs.

Q. Could you please summarize your instream flow requests for

Reach #2?

A. The instream flow requests for the Missouri River below Hauser Dam are divided into five seasonal periods to accommodate a variety of trout life history stages. The following instream flows are requested:

October 15-December 15 (4,878 cfs)
This period encompasses the brown trout spawning period. Since suitable spawning habitat is thought to be limited, it is critical to provide sufficient flows to ensure spawning success. The present high quality brown trout fishery is a product of past flow conditions. Areas of known spawning importance are not adequately watered at the wetted perimeter inflection point (3,500 cfs). Therefore, we believe that the most appropriate flow regime during the spawning period is the one which best approximates recent historical discharges (4,878 cfs).

December 16-March 15 (3,000 cfs)
During this period, brown trout eggs incubate, hatch, and pre-emergent fry are located in the gravel. A flow of 3,000 cfs would provide adequate conditions for egg and pre-emergent fry survival, prevent freezing of most eggs and fry, and minimize physical disturbance caused by fisherman walking on redds. This recommended flow does not represent optimal conditions for egg incubation, but protects the majority of incubating eggs.

March 16-April 30 (5,316 cfs)
May 1-June 30 (7,890 cfs)
This encompasses the periods of rainbow trout spawning and pre- and post-emergence of brown and rainbow trout fry in the river. The best approximation of recent historic flows are believed to be the most appropriate flows to maintain the trout population at its present abundance and health. Mean historic flows for March-April and May-June were approximately 5,316 and 7,890 cfs, respectively.

July 1-October 14 (3,500 cfs)
This is an important growth period for all trout life stages and forage fish in the reach. The study provided no evidence that daily flow fluctuations between 1,500 and 9,500 cfs adversely affected the trout populations in the short-term. However, effects of altered flows on fish food organisms were not studied. Long-term impacts to trout could be severe if the food supply was negatively affected. Because the study for the Montana Power Company did not derive an instream flow recommendation for this period, a flow of 3,500 cfs, the upper inflection point on the wetted perimeter-flow relationship, is requested.

I, Ronald L. Spoon, being duly sworn, states that the foregoing testimony is true.

Dated this 30th day of October, 1991.

Ronald L. Spoon

Ronald L. Spoon

Subscribed and sworn to before me this 30th day of October, 1991.

Debra McRae

Notary Public for the State of Montana residing at Helena, Montana.
My commission expires May 14, 1994

BIOGRAPHY
RONALD L. SPOON
October, 1991

PERSONAL:

Born March 4, 1958, Laurel, Montana
Social Security No. 516-82-3013

EDUCATION:

B.S. in Wildlife Biology, Aquatic Option (with honors), University of Montana, Missoula, MT, 1980.

M.S. in Fish and Wildlife Management. Montana State University, Bozeman, MT, 1985.

EXPERIENCE:

October 1990 - Present: Fisheries Biologist, Montana Department of Fish, Wildlife and Parks. Townsend, MT. Responsibilities include implementing fisheries management activities in Broadwater, Jefferson, and Silver Bow Counties.

March 1989 - October 1990: Fisheries Biologist, Montana Department of Fish, Wildlife and Parks. Philipsburg, MT. Responsibilities included acting as liaison between consulting firm contracted by ARCO (EA Engineering) and MDFWP. Assisted with field studies evaluating effects of metals contamination of the Clark Fork River. Summarized and interpreted fisheries information to be used for directing clean up efforts of the Superfund area in the Clark Fork River basin. Evaluated EA's field studies pertaining to instream flow methodology, trout habitat modeling, streambed sedimentation, trout fry emergence, water quality sampling, and fish population sampling in the Clark Fork River.

July 1988 - March 1989: Fisheries Fieldworker, Montana Department of Fish, Wildlife and Parks. Missoula, MT. Assisted biologist with designing and conducting field studies to evaluate trout population characteristics of the Big Blackfoot River.

May 1988 - July 1988: Research Specialist II, Montana Department of Fish, Wildlife and Parks. Missoula, MT. Reviewed information and analyzed data concerning metals contamination at Old Works Smelter Site on the flood plain of Warm Springs Creek near Anaconda, MT. Prepared endangerment assessment arguing for removal of smelter tailings.

July 1987 - February 1988: Fisheries Fieldworker, Montana Department of Fish, Wildlife and Parks. Missoula, MT. Developed a computerized database for fisheries data in the Upper Clark Fork River, and analyzed these data to evaluate potential reasons for depressed trout populations.

March 1986 - May 1987: Fisheries Biologist, Montana Department of Fish, Wildlife and Parks. Hamilton, MT. Conducted field studies to determine instream flow needs for the trout fishery of the Bitterroot River, and evaluated potential benefits of releasing supplemental water from Painted Rocks Reservoir.

April 1985 - December 1985: Fisheries Fieldworker, Montana Department of Fish, Wildlife and Parks. Missoula, MT. Conducted field studies to evaluate effects of pulp mill discharge on the trout fishery of the middle Clark Fork River. Field studies consisted of trout population inventories, water quality sampling, and habitat surveys of Clark Fork tributaries.

August 1984 - January 1985: Fisheries Fieldworker, Montana Department of Fish, Wildlife and Parks. Missoula, MT. Assisted with study design to evaluate effects of pulp mill discharge on the Clark Fork River trout fishery including: development of intergravel water quality sampling methods; trout egg/fry bioassay studies; and adult trout population surveys.

October 1981 - August 1984: Graduate Research Assistant, Cooperative Fisheries Research Unit, Montana State University. Bozeman, MT. Designed and conducted field studies to evaluate potential effects of hydroelectric peaking on trout spawning success in the Missouri River below Hauser Dam. Recommended a flow regime to Montana Power Company that would not significantly impact the sport fishery below Hauser Dam.

May 1981 - September 1981: Fisheries Fieldworker, Montana Department of Fish, Wildlife and Parks. Missoula, MT. Conducted electrofishing surveys on a wide variety of streams in the Clark Fork basin. Evaluated effects of Milltown Dam drawdown practices on trout populations by conducting a bioassay.

June 1980 - October 1980: Fisheries Fieldworker, Montana Department of Fish, Wildlife and Parks. Missoula, MT. Conducted electrofishing surveys on Clark Fork River tributaries to obtain baseline information prior to proposed stream alterations by Northern Tier Pipeline Co.

August 1979 - November 1979: Fisheries Intern, Montana Department of Fish, Wildlife and Parks. Kalispell, MT. As a volunteer, assisted with stream habitat surveys in the North Fork of the Flathead River drainage.

PROFESSIONAL ORGANIZATIONS:

Member, American Fisheries Society and Montana Chapter, American Fisheries Society

PUBLICATIONS:

Phillips, G.R. and R.L. Spoon. 1990. Ambient toxicity assessments of Clark Fork River water biassays, habitat inventory and metal residues in brown trout organs. Proceedings from Clark Fork Symposium, Missoula, MT.

Spoon, R.L. and D. Workman. 1989. Pushing forward on the Bitterroot. Montana Outdoors 20 (5): 18-22. Sept/Oct.

Peters, D.J. and R.L. Spoon. 1989. Preliminary fisheries inventory of the Big Blackfoot River. Report to MDFWP and Trout Unlimited, Missoula, MT. 45 pp.

MDFWP. 1988. Preliminary endangerment assessment: Effects of metals contamination at Old Works Operable Unit on aquatic biota of Warm Springs Creek, Montana. Report to Montana Department of Health and Environmental Sciences, Helena, MT. 33 pp.

Spoon, R.L. 1987. Evaluation of management of water releases for Painted Rocks Reservoir, Bitterroot River, Montana. Final Report to Bonneville Power Administration, project 83-463, Missoula, MT. 95 pp.

Spoon, R.L. 1985. Reproductive biology of brown and rainbow trout below Hauser Dam, Missouri River, with reference to proposed hydroelectric peaking. M.S. Thesis, Montana State University, Bozeman, MT. 144 pp.

White, R.G., G.A. Liknes, R.L. Spoon, and D.G. Carty. 1984. Potential impacts of altering discharge pattern from Hauser Dam, Missouri River, on fish populations. Final report to Montana Power Company. Montana Cooperative Fisheries Research Unit, Montana State University, Bozeman, MT. 235 pp.

White, R.G., G.A. Liknes, R.L. Spoon, and D.G. Carty. 1983. Potential impacts of altering discharge pattern from Hauser Dam, Missouri River, on fish populations. Annual report to Montana Power Company. Montana Cooperative Fisheries Research Unit, Montana State University, Bozeman, MT. 142 pp.

White, R.G. and R.L. Spoon. 1982. Potential impacts of altering discharge pattern from Hauser Dam, Missouri River, on fish populations. Annual report to Montana Power Company. Montana Cooperative Fisheries Research Unit, Montana State University, Bozeman, MT. 27 pp.

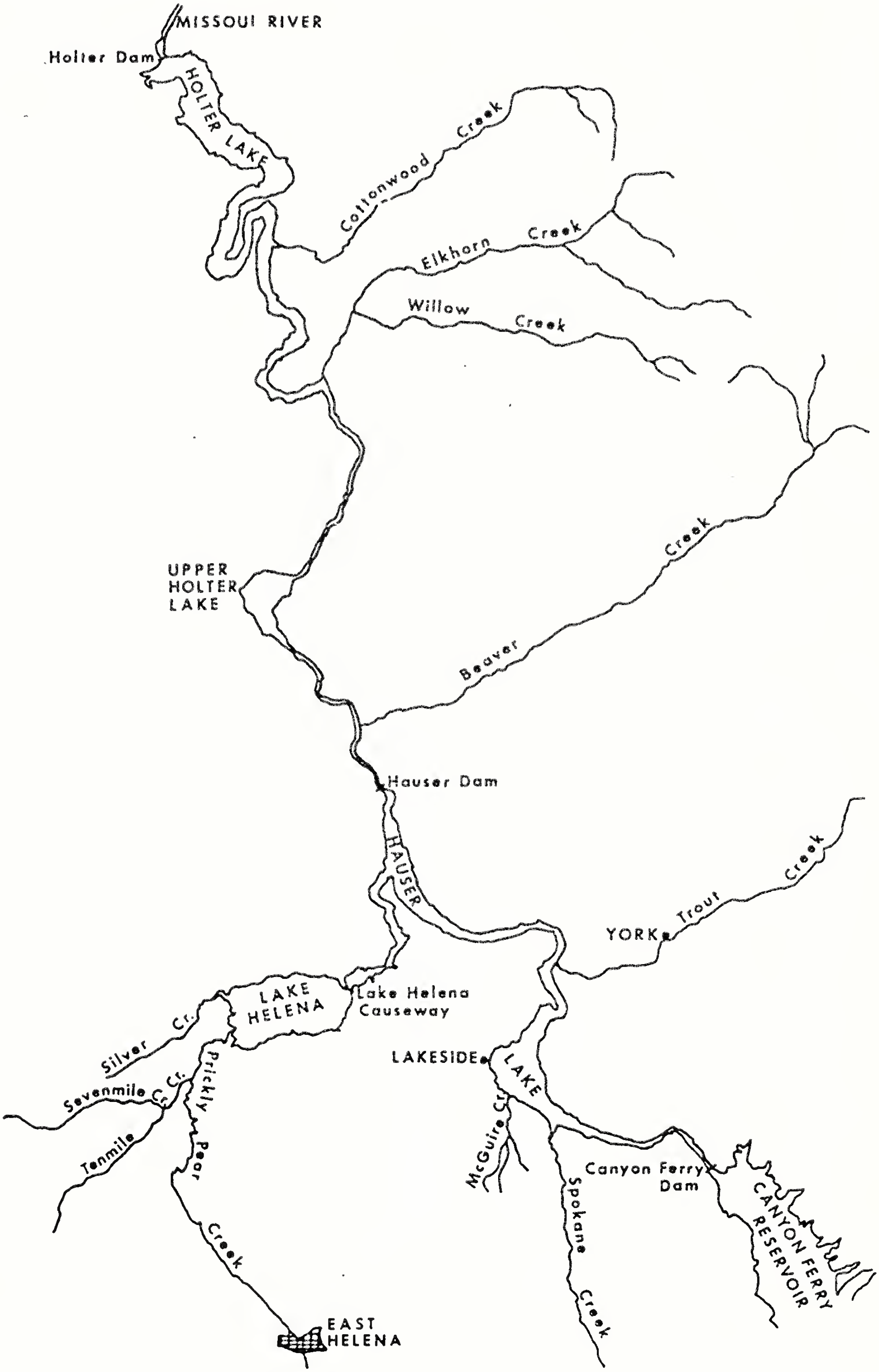
PAPERS PRESENTED:

Montana Chapter American Fisheries Society (Kalispell, Montana, 1987) - Fish population characteristics of the Upper Clark Fork River.

National Meeting, American Fisheries Society (Sun Valley, Idaho, 1985) - Reproductive biology of brown and rainbow trout below Hauser Dam, Missouri River, with reference to proposed hydroelectric peaking.

Montana Chapter American Fisheries Society (Helena, Montana, 1983) - Potential impacts of altering discharge pattern from Hauser Dam, Missouri River, on brown and rainbow trout spawning success.

Appendix A



Map of the Missouri River Basin between Canyon Ferry Dam and Holter Dam.

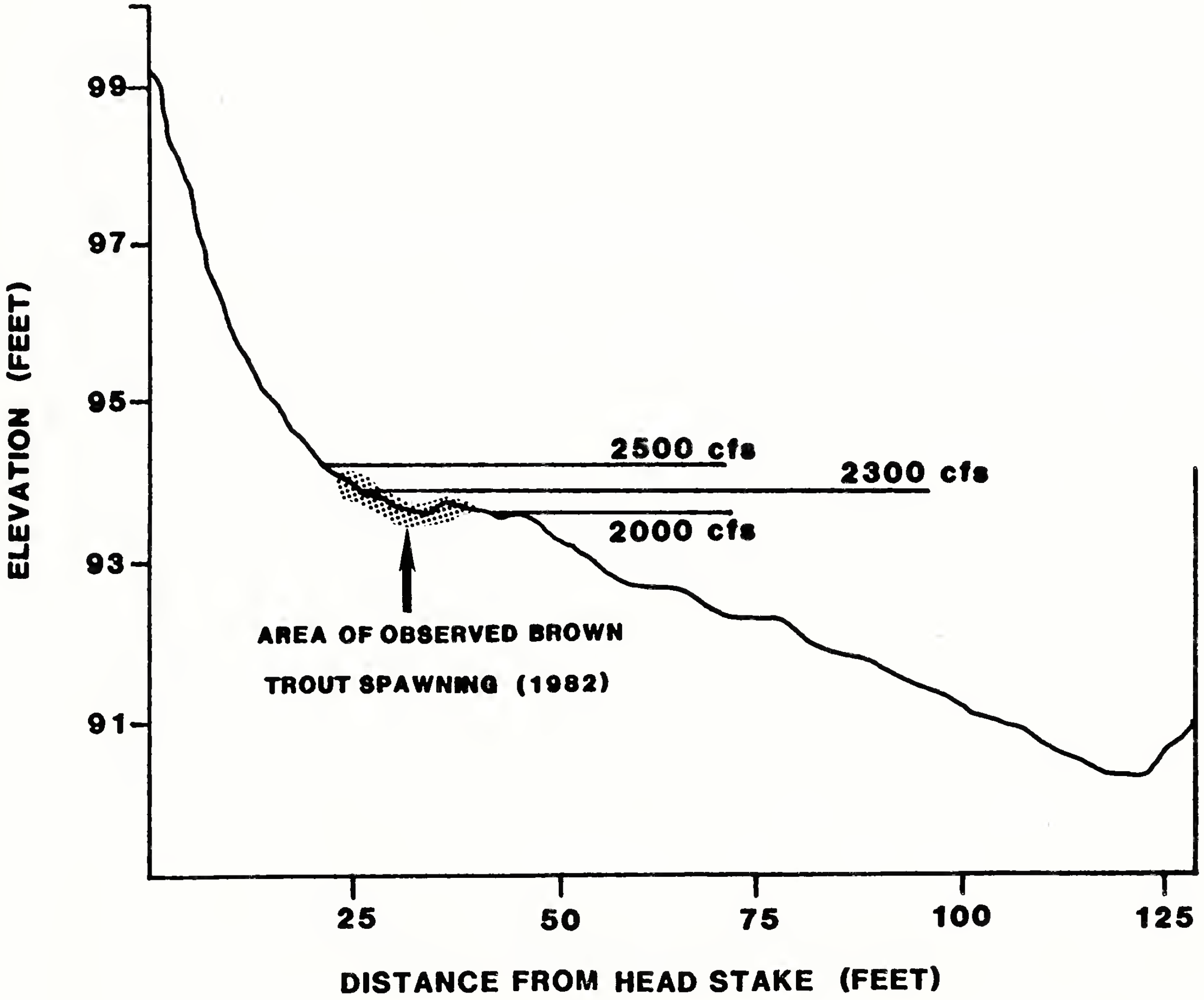


FIGURE 3.10-1

HAUSER PROJECT EXPANSION
FERC NO. 2188

METHOD OF DETERMINING
WETTED SPAWNING HABITAT

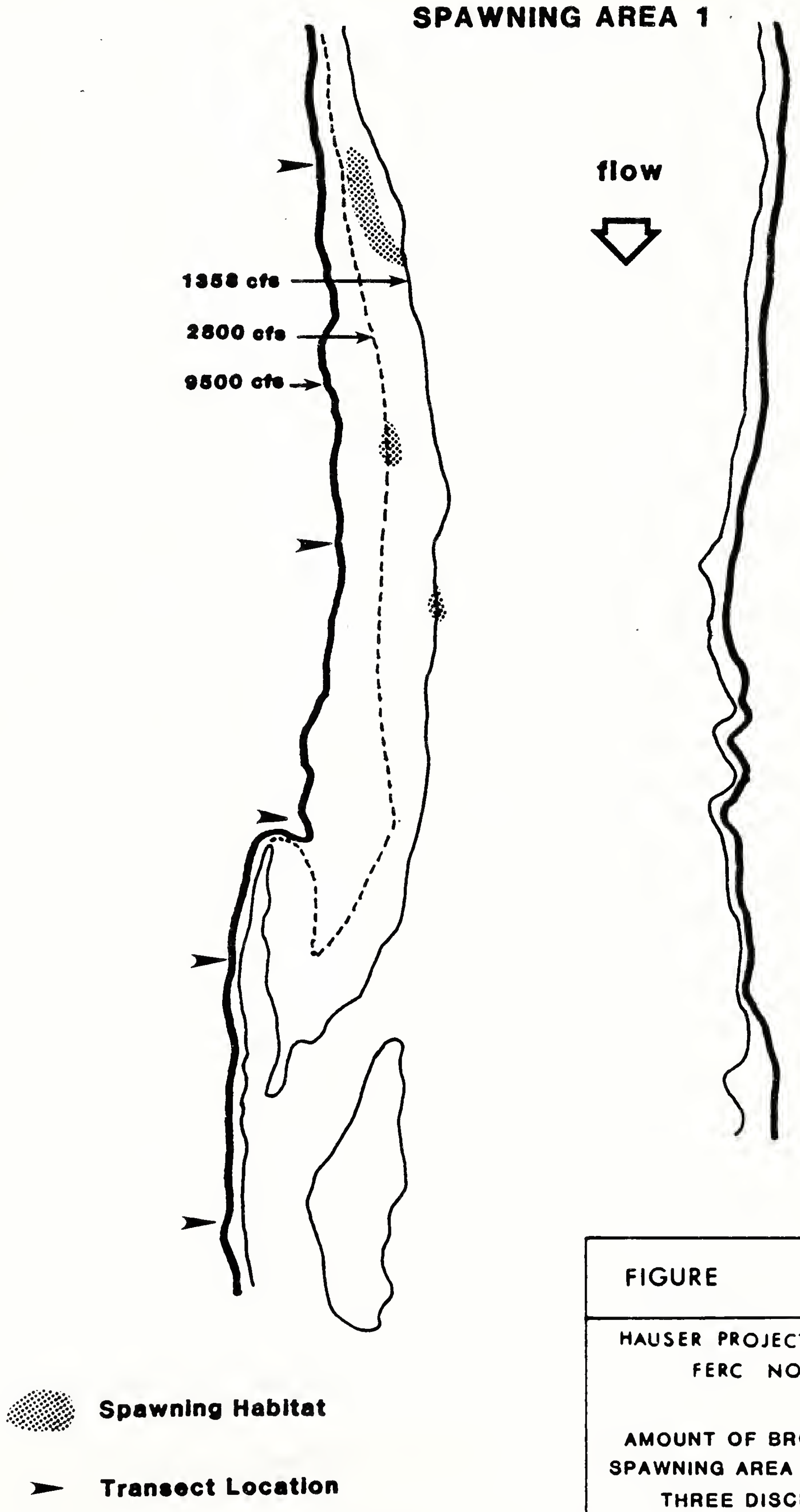
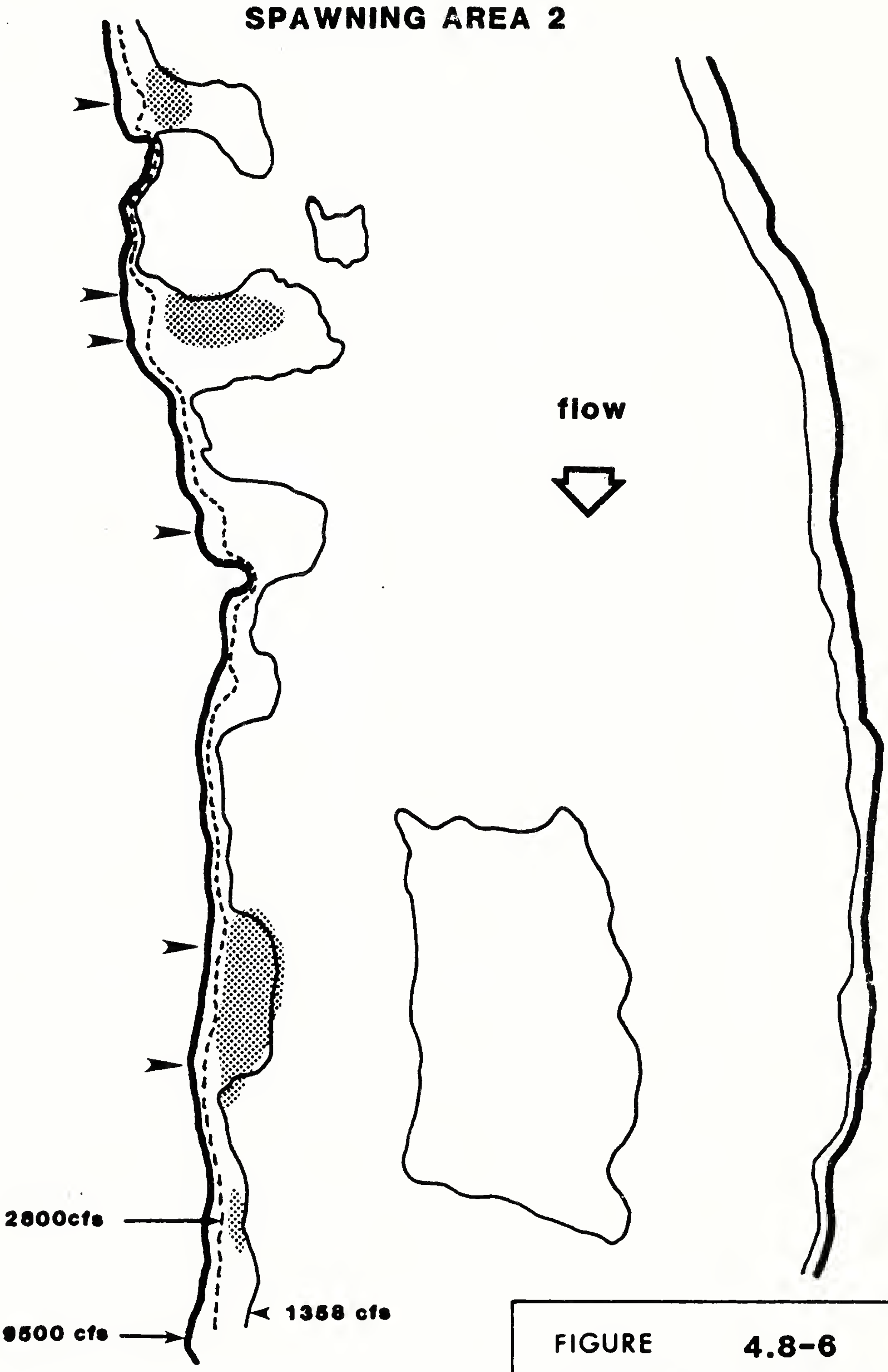


FIGURE 4.8-5

HAUSER PROJECT EXPANSION
FERC NO. 2188

AMOUNT OF BROWN TROUT
SPAWNING AREA WATERED AT
THREE DISCHARGES,
MISSOURI RIVER



▨ **Spawning Habitat**

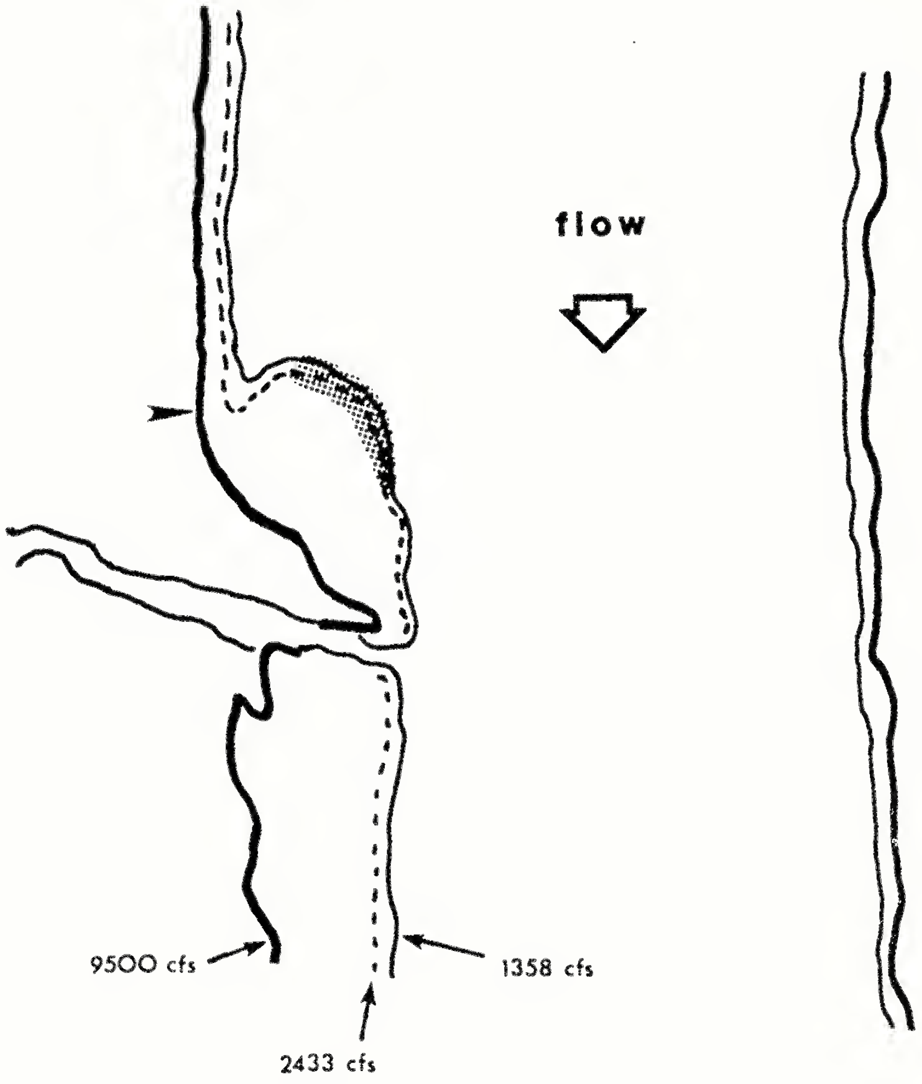
➤ **Transect Location**

FIGURE 4.8-6

HAUSER PROJECT EXPANSION
FERC NO. 2188

AMOUNT OF BROWN TROUT SPAWNING AREA WATERED AT THREE DISCHARGES, MISSOURI RIVER

SPAWNING AREA 3



▨ Spawning Habitat

➤ Transect Location

FIGURE 4.8-7

HAUSER PROJECT EXPANSION
FERC NO. 2188

AMOUNT OF BROWN TROUT SPAWNING AREA WATERED AT THREE DISCHARGES, MISSOURI RIVER

Prefiled Direct Testimony of Al Wipperman
on behalf of the
Montana Department of Fish, Wildlife and Parks

Q.	Please state your name and business address.
A.	My name is Alfred H. Wipperman. My address is Montana Department of Fish, Wildlife and Parks, 1420 East 6th Avenue, Helena, Montana 59620.
Q.	What is your present position?
A.	I am the Habitat Protection Bureau Chief in the Fisheries Division.
Q.	What is your educational background and employment experience?
A.	I received a B.S. degree in Fish and Wildlife Management from Montana State University in 1961 and a M.S. degree in Fish and Wildlife Management from MSU in 1963.

I have worked full time for the DFWP in various capacities since 1963. I was a field fishery biologist in the Dillon area for five years. I administered the Stream Protection Act as a habitat biologist in Helena for one year, worked as a planning ecologist on the Smith River Inventory and Planning Study for two years and served as the Department's Helena liaison with the Department of Health and Environmental Sciences as a pollution control biologist for three years. From 1974 to 1988, I was located in Great Falls as the Regional Fishery Manager for Northcentral Montana. I have held the position of Habitat Protection Bureau Chief in Helena since 1988.

During my tenure with the Department, I have attended several training workshops to improve job skills necessary for state of the art application and knowledge. Those training workshops applicable to the Department's instream reservation process include:

1. "Streamflow Measurements" conducted by Ron Shields, USGS.

2. "Wetted Perimeter Methodology" conducted by Fred Nelson, DFWP.

3. "Expert Witness Seminar" by James Merrill, Attorney at Law.

4. "Stream Mechanics" by Don Reichmuth, P.C.

5. "River Electrofishing and Fish Population Estimates" by Richard Vincent, DFWP.

My work experience has involved stream habitat and fish population inventories in the Big Hole, Beaverhead, and Smith River drainages. I designed and conducted a study on the impacts of reduced stream flows on fish populations on Blacktail Creek in Beaverhead County. Other experience involves aquatic invertebrate and water quality sampling and analysis in the Clark Fork River from Warm Springs to below Missoula. I have done general fisheries management duties involving fishing regulation and fish stocking recommendations, creel census, angler surveys, pond and reservoir fishery surveys and writing management plans. I have administered the Department's Stream Protection Act and assisted several conservation districts in setting up and administering the Natural Streambed and Preservation Act.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to support that portion of the Department's reservation request for the Smith River from the river's origin at the confluence of the North and South Forks downstream to its confluence with the Missouri River and also for Bean Lake. I gathered the data for the Department's reservation request for three reaches of the Smith River described in Volume 3, pages 3- 139 to 3-150, and for Bean Lake on pages 3-451 through 3-454, of the application.

Q. What methods were used on the Smith River to derive instream flow requests?

A. Methods for determining the Department's instream flow requests on the Smith River are described in Volume 1 and will be supported by the testimony of Fred Nelson. The wetted perimeter inflection point method was used for instream flow determinations.

Q. What instream flows were requested for the Smith River?

A. Instream flows were requested for three reaches of the Smith River as follows:

Reach #1. Confluence of North and South Forks of the Smith River to confluence of Sheep Creek. - 90 cfs.

Reach #2. Confluence of Sheep Creek to confluence of Hound Creek. - 150 cfs.

Reach #3. Confluence of Hound Creek to Missouri River. - 80 cfs

Q. Why is an instream flow needed for the Smith River?

A. The Smith River is one of the most popular trout fisheries in the state. An instream flow is necessary to maintain the existing rainbow and brown trout populations in the river. The requested instream flow is needed to maintain habitat for spawning, rearing and production of aquatic food organisms used by rainbow and brown trout, the two most important gamefish in the river. The Department has managed the Smith River as a wild trout fishery since 1974 when all trout stocking was discontinued. The river has become an important water for recreational floating, especially through the 56-mile canyon area from Sheep Creek to the Eden Bridge access near the confluence of Hound Creek. Fishing comprises one of the most important activities while floating the river. Therefore, maintenance of existing habitat and trout populations will continue to provide a quality experience for outdoor recreation associated with the river.

Q. What are the "Murphy Rights" on the Smith River and why is the Department's instream request less than the Murphy Rights filed in 1970?

A. The "Murphy Rights" filed in 1970 were based on interpretation of flow data obtained by the USGS on the lower river near Eden. At that time, the Department realized differences in the ecological zones of the river, but insufficient data was available to accurately determine minimum flows necessary to maintain the fishery. I was responsible for a three-year study in 1969 to determine the fish and wildlife resources in the Smith River drainage (Wipperman, A.H. 1973. Section 1. Fisheries Inventory and Plan. Smith River drainage inventory and planning investigation. Fed. Aid to Fish & Wildlife Restoration Project No. FW-1-R-3, Job I-a. 130 pp., 1973). That study involved considerable field work identifying fish populations, habitat conditions and recreational opportunities. The study helped us understand the ecology of the Smith River and the flows necessary to maintain aquatic life. The Wetted Perimeter Inflection Point Method was developed after the study was completed. It allowed us to determine the minimum flows necessary to maintain trout populations and to refine our earlier flow determinations. The refined recommendations are contained in the reservation application.

Q. Why is the instream flow request higher in the middle portion of the river (Reach #2) from the confluence of Sheep Creek to the confluence of Hound Creek than the requests for the upper (Reach #1) and lower portions (Reach #3) of the river?

A. The Smith River changes character at the confluence of Sheep Creek. In normal years, spring flow from Sheep Creek nearly

doubles the flow in the Smith River. The morphology of the river channel changes accordingly to accommodate this flow. Channel width downstream from Sheep Creek is nearly double that of the river channel above. It stands to reason that more flow would be necessary to cover the wider channel bottom to maintain the habitat necessary for trout. Information obtained from the Wetted Perimeter Inflection Point Method supports the need for greater flow in the middle portion of the river.

Downstream from the mouth of Hound Creek (Reach #3), trout habitat gradually diminishes. The gradient of the river becomes lower and allows fewer riffles to occur. In this reach, the river bottom changes from cobble and gravel to mostly sand and silt. Agricultural practices have also contributed to changes in the river through channel alterations, rip-rapping, riparian removal and irrigation withdrawals. Although the river channel in the upper half of Reach #3 is similar to that in Reach #2, the lower quality trout habitat in Reach #3 was the basis for requesting a lower flow request.

Q. Why wasn't wetted perimeter data obtained for Reach #3?

A. The wetted perimeter transects were established in 1980 on river sections involving the Department's Murphy Rights in reaches #1 and #2. The Murphy Rights extended from Fort Logan to the mouth of Hound Creek. The river channel characteristics in the upper half of Reach #3 appear to be similar to Reach #2. It was felt that data collected on the river in Reach #2 (above Hound Creek) could apply to at least part of the river in Reach #3.

Q. What is the water availability on the Smith River to meet the instream flow requests?

A. The minimum flow requested is available in many years. Minimum flow was higher than the Department's request, for example, when we studied the river in 1970. USGS records reveal several years when late summer flows were above the Department's minimum request. However, drought conditions in recent years have produced below average flow and critical minimum flows. As a result, we have seen nearly a 50% decline in rainbow and brown trout numbers from 1987 to 1990 in the mid to lower canyon area of the Smith (Reach #2). (Liknes, G.A., W.J. Hill and S.A. Leathe. 1991. Northcentral Montana Coldwater Streams. Job Progress Report, Fed. Aid in Fish and Wildlife Restoration Act, Montana Project No. F-46-R-4, Job I-G 17 pp.) This decline is undoubtedly due to low river flows. Therefore, the Department's minimum flow request would prevent conditions from becoming worse and would protect flows if additional water becomes available in the future.

Q. Did you prepare information for a reservation request on Bean Lake?

A. Yes.

Q. Why was a water reservation requested for Bean Lake?

A. Bean Lake is the only natural lake of any significance in all of Northcentral Montana. Although the lake is mostly on private land, the Department owns a 17-acre fishing access on the lake and manages the fishery intensively with rainbow trout. The lake is a popular recreation area and provides nearly 10,000 angler days of fishing per year. All other lakes and reservoirs were either owned entirely by private parties or the waters were mostly committed for other uses such as irrigation. A water reservation would protect the significant fishery and recreational use of this lake.

Q. How was the water request determined?

A. We established a bench mark near the lake shore to use as a reference for monitoring water levels. Water level of the lake's surface was measured nearly every month from June 1975 to September 1978. The surface of the lake fluctuated 2.49 feet over this time period. The area of Bean Lake at the observed low surface water elevation is 200 acres. The volume of the lake was calculated to contain 2.150 acre-feet. That volume plus the water level fluctuation (2.49 feet x 200 acres) was the volume or acre-feet of water requested by the Department.

Q. Why did the Department request a reservation of basically all the water in the lake?

A. Standing bodies of water are most productive biologically when little fluctuation occurs in the water level. The shallow shoreline areas produce aquatic plant and animal life necessary for good growth of trout. Drawdown of water levels in lakes and reservoirs exposes these shoreline areas, thereby drying up the plant life. This consequently affects aquatic invertebrate populations that are important food items for trout. Drawdown also reduces the area and volume of water in the lake, thereby reducing the abundance and growth of fish. The exposed mud flats become aesthetically displeasing and make the whole area around the lake less desirable for recreation.

Q. Could fish still survive in the lake if it was drawn down significantly and then refilled?

A. It depends on how far down the lake was drawn. The maximum depth of Bean Lake is about 30 feet. A drawdown of 20 feet

remaining overwinter would probably kill all the fish because of oxygen depletion under the ice. Bean Lake has no stream inflow. Water supply for the lake is entirely from precipitation, groundwater and seepage. Therefore it may take several years for the lake to refill. Meanwhile, trout growth would be slower because of a reduced food supply and fewer trout could be supported in the lake. This would directly affect fishing opportunity on the lake.

Alfred H. Wipperman being duly sworn, states that the foregoing testimony is true.

DATED this 30 day of October, 1991.

Alfred H Wipperman

Alfred H. Wipperman

Subscribed and sworn to before me this 30 day of October, 1991.

Curtis E Larsen

Notary Public for the State of Montana
Residing at Helena, Montana
My commission expires July 6, 1994

BIOGRAPHY - AL WIPPERMAN

PERSONAL:

Born July 21, 1934, Conrad, Montana
Social Security Number: 517-44-4655

EDUCATION:

Elementary. Conrad High School, 1952
Bachelor of Science, Fish and Wildlife, Montana State University, 1961
Master of Science, Fish and Wildlife, Montana State University, 1963

EXPERIENCE:

1988 - present. Montana Department of Fish, Wildlife and Parks. Habitat Protection Bureau Chief. Responsible for administration of statewide habitat programs involving the Stream Protection Act, the Natural Streambed and Land Preservation Act, habitat enhancement programs, stream inspection contractors, new FERC licensing, habitat education programs and water pollution control programs.

1974 - 1988. Montana Department of Fish, Wildlife and Parks. Responsible for administering fishery management programs in the north central region of Montana. This involved preparing work plans, budgets, equipment needs and supervision of biologists and technicians. Other duties involved preparation of fish planting program, fishing regulation recommendations, coordination of stream protection programs, monitoring field projects, coordination with landowners and sportsman groups and various agencies.

1971 - 1974. Montana Department of Fish, Wildlife and Parks. Water Pollution Control Biologist, Helena. Responsible for coordinating water quality studies and investigations as related to fisheries with the Water Quality Bureau, Department of Health. Investigated water pollution complaints, violations and fish kills, monitored water quality in problem areas. Assisted with development of water quality standards for protection of aquatic resources. Helped prepare manual for pesticide applicators training workshops.

1969 - 1971. Montana Department of Fish, Wildlife and Parks. Planning Ecologist, Townsend. Responsible for development of a fisheries resource plan based on field investigations in the Smith River drainage. Conducted fish population inventories, water quality monitoring, flow measurements, landowner survey, mapping, and preparation of final report.

1968 - 1969. Montana Department of Fish, Wildlife and Parks. Habitat Preservation Biologist, Helena. Administered the Stream Preservation Act. Duties involved reviewing construction plans for impacts on stream habitat, attended field inspections and meetings with governmental entities proposing projects influencing fish habitat. Recommended procedures and actions to reduce, enhance or mitigate stream habitat influenced by construction activities.

1963 - 1968. Montana Department of Fish, Wildlife and Parks. Fishery Project Biologist, Dillon. Responsible for survey and inventory of waters in the Dillon area to obtain information for fishery management purposes. Collected fish population data by electrofishing and netting. Conducted creel census, stream habitat inspections and recommendations, and initiated a study to determine impacts of low stream flow on trout populations.

1959 - 1962. Montana Department of Fish, Wildlife and Parks. Biologist Aid, Ovando, Thompson Falls, Bozeman. Worked three summers and one winter assisting Department biologists with collection of fishery data by electrofishing and netting. Conducted creel census, fish habitat survey work, mounted fish scales for age and growth studies, maintained fishery equipment.

PUBLICATIONS:

Wipperman, A.H. 1965. Big Hole River sport fishery. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts. Montana Project F-9-R-13, Job No. 1-a. 10 pp.

Wipperman, A.H. 1965a. Inventory of the waters of the project area. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts. Project Report F-9-R-13, Job No. 1. 16 pp.

Wipperman, A.H. 1967. A study of reduced stream flows resulting from irrigation. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-9-R-15, Job VI. 13 pp.

Wipperman, A.H. 1967a. Inventory of the waters of the project area. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-9-12-15, Job I. 14 pp.

Wipperman, A.H. 1969. A study to determine the effects of the mining industry to trout streams. Job Completion Report,

Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-9-R-17, Job I. 10 pp.

Wipperman, A.H. and A. Elser. 1968. Mountain lake survey, District 3. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-32-R-4, Job IV. 5 pp.

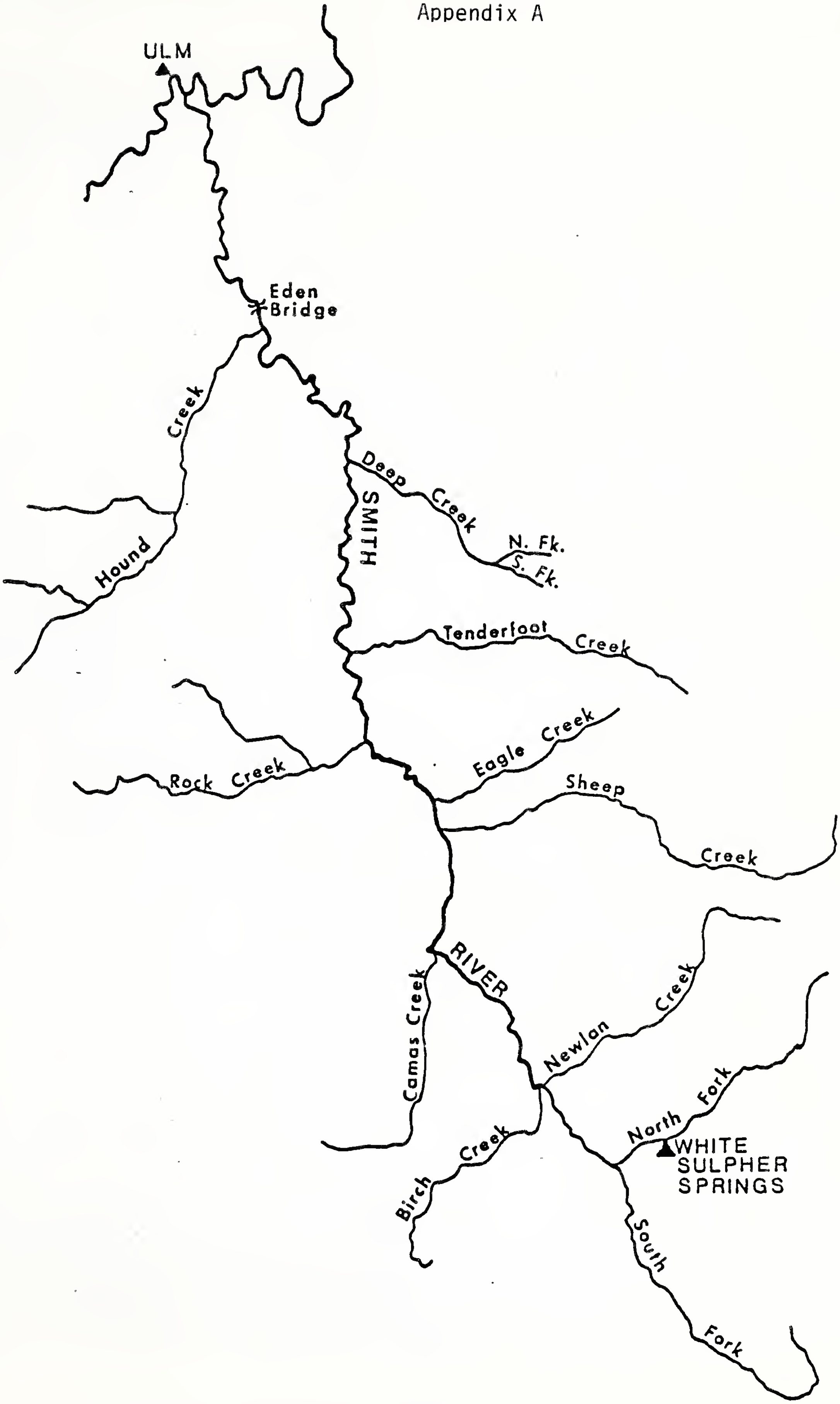
Wipperman, A.H. 1973. Section I. Fisheries Inventory and Plan. Smith River drainage inventory and planning investigation. Federal Aid to Fish and Wildlife Restoration Project No. FW-1-R-3, Job I-a. 130 pp.

Wipperman, A.H. 1981. Smith River and Tributary Instream Flow Study. Instream Flow Evaluation for Selected Waterways in Western Montana. Contract No. 53-0343-0-305. U.S. Forest Service, Missoula, Montana. pp. 305-312.

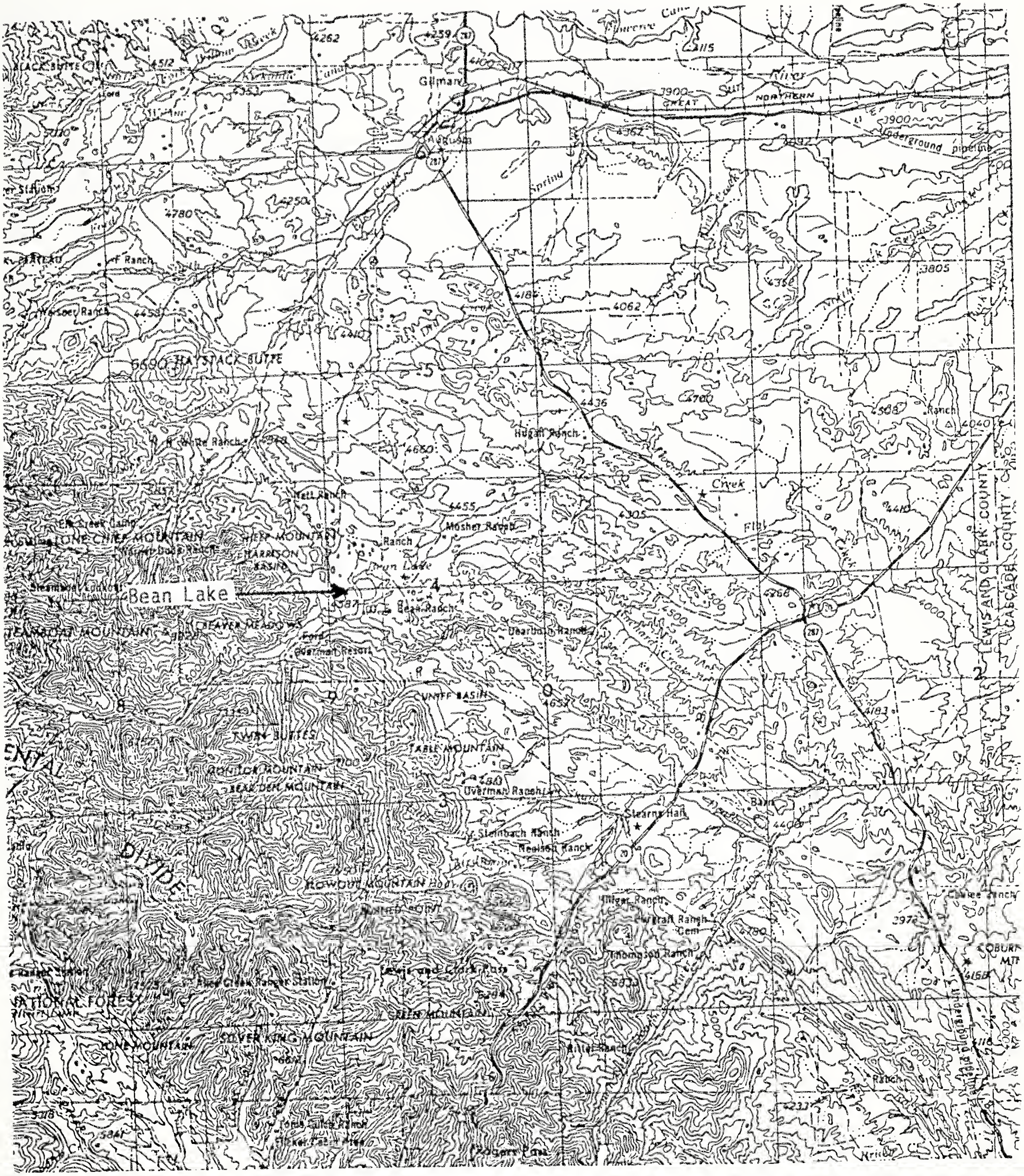
Wipperman, A.H. 1988. Stream Protection Coordination. Job Progress Report, Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-46-R-1, Job VI-a. 15 pp.

Wipperman, A.H. 1991. Streambank Permitting and Surveys. Job Progress Report, Federal Aid in fish and Wildlife Restoration Acts. Montana Project No. F-46-R-4, Job VI-d. 4 pp.

Appendix A



Map of the Smith River Drainage.



Location map for Bean Lake.

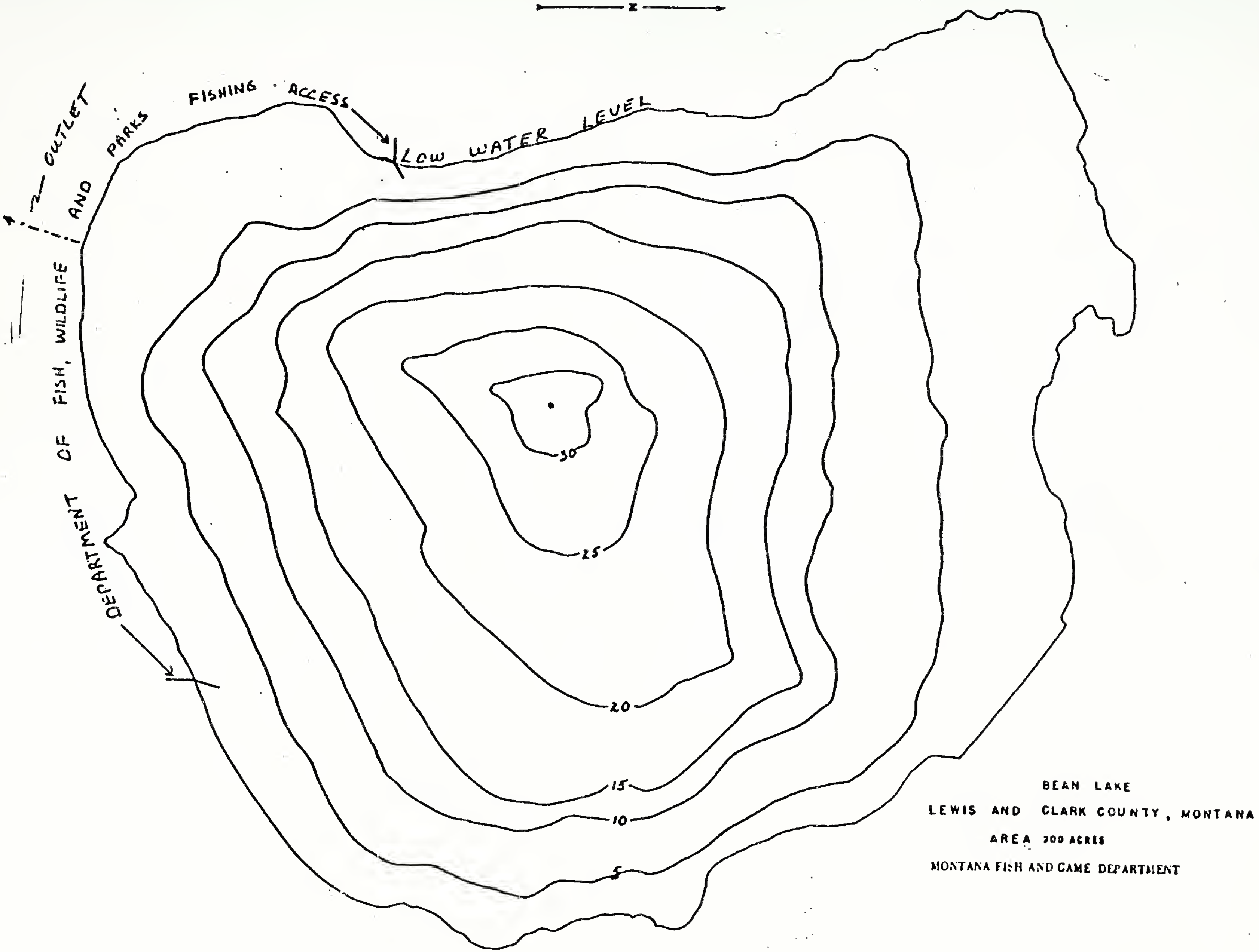

N
OUTLET
FISHING ACCESS
LOW WATER LEVEL
DEPARTMENT OF FISH, WILDLIFE AND PARKS
30
25
20
15
10
5
BEAN LAKE
LEWIS AND CLARK COUNTY, MONTANA
AREA 200 ACRES
MONTANA FISH AND GAME DEPARTMENT

Figure 3-101. Contour map of Bean Lake.

PRE-FILED DIRECT TESTIMONY OF GARY OLSON
On Behalf of the Montana Department
Fish, Wildlife and Parks (MDFWP)

Q. Please state your name and business address.

A. Gary Olson, MDFWP, 1008 Sunset Boulevard, Conrad, MT 59425

Q. What is your present employment?

A. I am a wildlife biologist employed by Montana Department of Fish, Wildlife and Parks.

Q. Please state your educational background and experience.

A. I graduated from Choteau High School in 1967, attended the University of Montana from 1967-1973, earning a B.S. in Wildlife Management and a M.S. in Range Management. After graduate school I was employed by Great Falls Production Credit Association (now called Farm Credit Services) as a loan officer for 2-1/2 months. My responsibilities included preparing personal property inventories and financial statements for customers.

In September, 1973, I was hired to manage the Newman Ranch, west of Choteau, Montana, and was in that capacity until November, 1977. My responsibilities there included all phases of the 600 head cattle and hay operation, as well as payroll and monthly accounting chores.

In November, 1977, I began employment with Montana Department of Fish, Wildlife and Parks as a wildlife biologist based out of Conrad, Montana, and have served in that capacity since that time. Job responsibilities for the Department include gathering data and providing recommendations for hunting and trapping seasons in Glacier, Toole, Liberty, Pondera, and portions of Teton, Chouteau, and Cascade counties. Data gathering includes annual census and production information for all big game, bird, and fur species. Additionally, I am responsible for interagency cooperation, i.e., representing the Department on various committees and task forces with other state or federal agencies. Public relations is also an important part of the job; meeting with various user groups, landowners and professional organizations.

Planning, implementing, and monitoring of habitat projects are a major part of my present activities. I am responsible for biological activities on the Blackleaf Wildlife Management Area that include a range/habitat management grazing system, wildlife surveys, and vegetative trend monitoring, as well as

monitoring the effects of hunting on wildlife populations and the general public acceptance of hunting seasons. I have worked extensively on wildlife and habitat enhancement projects in the area since 1979. As area biologist, it is my responsibility to design, implement and monitor any management activities that occur on the WMA. A more detailed biography is attached to this testimony.

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to support that portion of the Department's water reservation request for the Antelope Butte Swamp based on the need to maintain adequate water levels to prevent a loss of wetland habitats and the wildlife species that depend upon them.

Q. What portion of the Department's application covers material that is supported by your testimony?

A. Pages 3-455 through 459 of the application.

Q. What was your involvement in preparation of the Department's application for reservations of water in the Missouri River Basin above Fort Peck Dam?

A. I prepared the portion of the application described in the previous question except that I did not prepare the portion of that section dealing with the method of deriving the water level request or the water level request itself on page 3-459.

Q. How was the water level request determined?

A. The request is based on the Department's S.B. 76 claim for Antelope Butte Swamp filed with the Montana Water Court. (Form No. 76-0 R2/80). A copy of the claim, dated April 27, 1982, is attached as Appendix A of this testimony.

Q. Why is the Department requesting a water reservation for Antelope Butte Swamp?

A. Antelope Butte Swamp is part of the MDFWP Blackleaf Wildlife Management Area which is located about 14 miles west of the community of Bynum in Teton County. Maps showing the location of Antelope Butte Swamp are attached and are incorporated in this testimony. The Blackleaf Wildlife Management Area was purchased in 1979 to ensure that adequate winter range was available for migratory wildlife and that the recreational public has access to this wildlife resource for a variety of needs. The diversity of plant communities and their arrangement provide year-round and seasonal habitats for whitetailed and mule deer, elk, black and grizzly bear, wolf

(both grizzly and wolf are federally protected threatened and endangered species), mountain lion, bobcat, lynx, beaver, mink, muskrat, sharptailed, ruffed, spruce, and blue grouse, as well as numerous waterfowl species. Wildlife not managed by hunting seasons or bag limits such as birds of prey, songbirds, small mammals, etc. are not listed here but are still important to the overall ecological importance and enjoyment of the area by the public.

Elk and mule deer migrate to the area in late fall and remain until late spring. Other above-mentioned species use the area on a year-round or seasonal basis. Important winter/spring vegetative types include aspen, willow, cottonwood, Douglas fir, and limber pine. Aspen, willow, and cottonwood community types are commonly found along stream corridors and perennially moist locations. These cover types are important for protection from weather, provide resting and escape cover, and offer a wide variety of forage plants in the understory.

The Antelope Butte Swamp is a perennial wetland area of approximately 240 acres within the Blackleaf WMA, fed by No-Name Creek as well as a private diversion from Muddy Creek. Diverted water directly enters the swamp where it is temporarily stored before leaving the east end of the swamp for use on private irrigated lands. Standing water creates a vegetative mosaic, both inside and outside the perimeters of the wetland. Wet meadows and aspen/willow groves surround the swamp and provide cover needed by wildlife. This is emphasized by the winter densities of deer and elk using this portion of the WMA, as well as spring and summer use by bears. Grizzly bears, in particular, are drawn to the area during the spring to feed on succulent plants that grow in the moist environment of the swamp.

The Department has a responsibility to provide a variety of diverse habitats for wildlife use, while being good neighbors to surrounding landowners. These landowners, in most cases, do not wish to have additional numbers of elk, and especially grizzly bears on their property.

Q. What effects would the Department's application for water reservations have on the present condition of the Antelope Butte Swamp?

A. The application for water reservation in the Antelope Butte Swamp will not change the condition of the area, but rather, maintain the water levels necessary to keep cover and forage species healthy and available for wildlife use. High visibility species like elk and grizzly bears will continue to use Department property, rather than placing undue hardship on adjacent ranches.

Q. What potential effects are there of not having adequate water reservations for the Antelope Butte Swamp?

A. If the area is drained or even periodically de-watered so that water no longer stands for extended periods of time in the interior of the swamp, the vegetation will begin to change toward less water-loving plants, and generally fewer palatable and cover-producing species. As a result, the vegetative composition in and around the area will change over time, decreasing the amount of cover and forage available to wildlife using the WMA. The possibility of increasing game depredation on adjacent lands because of food and cover changes are a real concern as well. Black and grizzly bears are of particular concern because any food shortages in the swamp are likely to cause these animals to move to private lands to meet their food needs.

Gary Olson, being first duly sworn, states that the foregoing testimony is true.

Dated October 29, 1991.

Gary R. Olson
Gary Olson

Subscribed and sworn to before me this 29th day of October, 1991.

NOTARY PUBLIC for the State of
Montana

Residing at ____________, Montana.

My Commission expires ____________

Biography

Gary R. Olson

PERSONAL DATA:

Age: 42
Born: Great Falls, Montana (5/27/49)
Marital Status: Married, two sons
Address: 1008 Sunset Blvd., Conrad, MT. 59425
Phone: 278-7754

EDUCATION:

1967 - graduated from Choteau High School.

1971 - B.S. Wildlife Biology, U. of Montana (honors).

1973 - M.S. Resource Conservation, School of Forestry, U. of Montana (high honors).

EXPERIENCE:

1949-1970 - worked on family cattle ranch.

1967-1969 - assistant to curator of paleontology museum, U. of MT.

1971 - small mammal trapper for zoology dept., U. of MT.

1971 - worked for florist/nursery in Missoula.

1971 - range technician, USFS, Madison District, Ennis, MT.

1971-1973 - research assistant, U. of MT. School of Forestry.

1973 - thesis title: *Range Condition on Abandoned Croplands in Northcentral Montana*

a. study to determine range condition and trend for Deep Creek Grazing Ass'n., Choteau, MT.

b. prepared complete vegetative inventory, sampling technique, soils analysis, weather summary, history of use, and computer/statistics package.

1973 - employed by Federal Land Bank-Production Credit Ass'n. in Great Falls, MT., as loan officer.

a. appraisals and inventory of farms and ranches.

b. financial statements prepared for creditors.

1973-1977 - manager of Newman Ranch, Choteau, MT.

1978-1979 - Assisted Nature Conservancy with preparation of environmental documentation reports for various conservation easements and acquisitions making up the Pine Butte Preserve Project.

1977-Present - Area biologist for MT. Dept. Fish, Wildlife, Parks, Conrad, MT.

a. gather data necessary for recommending hunting seasons, bag limits, and quotas on nine species of big game, seven species of upland game birds, migratory waterfowl, and furbearers.

b. population census, condition, trend, seasonal distribution, and specific environmental effects on various wildlife populations.

c. responsible for preparing monthly and annual summaries of data/work accomplished.

d. interagency cooperation: BLM, USFS, SCS, Bureau of Reclamation, US Fish and Wildlife Service, MT. Dept. State Lands, MT. Dept. Nat. Res., Bureau of Indian Affairs, Blackfoot Tribe, Park Service, Alberta Dept. Fish and Wildlife, and five Conservation Districts. Interagency cooperation includes assisting in development of environmental assessments, impact statements, and cumulative effects analyses.

e. public organizations: Backcountry Horsemen, Lake Francis Wildlife Ass'n., Hi-Line Sportsmen's Club, Pondera Sportsmen's Group, Teton County Sportsmen's Club, Badger-Two Medicine Alliance, Teton Sportsmen/ Landowner Ass'n., North Marias Landowner/Sportsmen Group, Boone and Crockett Club and The Nature Conservancy.

f. Public information and education: all of the above, work with KSEN radio in Shelby, area

schools, numerous civic groups, host annual FFA range judging camp on Blackleaf WMA, annually contribute programs for county conservation districts annual banquets and range tours, hosted Society For Range Management summer range tour in 1985 on Blackleaf WMA, have written five articles for Montana Outdoors, interviewed by KRTV about black bears, have prepared and presented 70 wildlife programs in the last 24 months.

g. routinely monitor forage utilization transects on elk winter ranges, establish and monitor range condition and trend transects on wildlife management areas and Federal lands, prepare resource management plans for wildlife management areas. Range work involves habitat typing, vegetative identification, data entry, interpretation and analysis.

h. have conducted research projects involving human-related impacts to mule deer and elk. These projects involve use of radio telemetry equipment, various immobilants, helicopters and fixed-wing aircraft, and computer assisted statistical analyses. Final reports have been prepared in scientific journal format.

i. prepare and negotiate grazing and hayland contracts with lessees on Blackleaf Wildlife Management Area.

j. Have completed five habitat improvement contracts with area farmers in last two months, consisting of stipulations for seeding various grasses and legumes for dense nesting cover, small grains for food plots, planting several varieties of trees and shrubs for winter cover and range management suggestions for improved upland bird nesting success.

k. designed and implemented high intensity, short duration livestock grazing system for Blackleaf Wildlife Management Area in order to enhance vegetation for wintering big game.

1985-1991 - Elected to Board of Trustees, Conrad School District #10. Elected chairman, April, 1987 and 1990.

1989-present - Appointed to Conrad Police Commission.

ORGANIZATIONS AND ACTIVITIES:

Range leader, Teton County, Montana Rangeland Resource Program, 1976-1977.

Chairman, Teton County Weed District, 1974-1977.

Teton County Bicentennial Committee.

Hedrick School for Stockmen, Fort Collins,CO.,1975.

Select Sires Artificial Insemination School, 1977.

Member Society For Range Management, 1972-1983.

Member The Wildlife Society (various times).

Member Montana Chapter of The Wildlife Society, Secretary-Treasurer, 1983-85.

Member National Wildlife Federation

Past member (non-active) Phi Sigma Biological Society

Member Internal Review Committee for evaluation of wildlife on private lands, MT. Dept. Fish, Wildlife and Parks, 1982-1983.

Guest speaker, Professional Guides and Outfitters Convention, Kalispell, MT., 1984.

Guest speaker at two State Backcountry Horsemen Conventions, 1983, 1986.

Board of trustees, School District #10, Conrad, MT., 1985-, chairman 1987-1988, 1990-1991.

Cub Scout Den Leader, 1986-89.

Little League coach, 1987-88.

Various awards from Extension Service, FFA, 4-H, and schools for programs and assistance. Honorary FFA Chapter Farmer, 1988-89.

Guest speaker at Boone and Crockett Club seminar, U. of Mt., October, 1986.

Guest speaker at North American Wildlife Conference in Quebec, Canada, March, 1987 and Denver, Colorado, March, 1990.

Guest Speaker, Montana Bowhunters Association Annual Meeting, Billings, MT., 4/7/90.

POPULAR ARTICLES:

Olson, G.R. 1980. Resources in conflict. Montana Outdoors. 11(5):27-32.

Olson, G.R. 1984. Department Lands: Blackleaf Wildlife Management Area. Montana Outdoors. 15(5):15-17.

Olson, G.R. 1987. Goats, Curley Bear, and common sense. Montana Outdoors. 18(4):34-37.

Olson, G.R. 1990. Bulls on the TRMR. Montana Outdoors. 21(6):16-20.

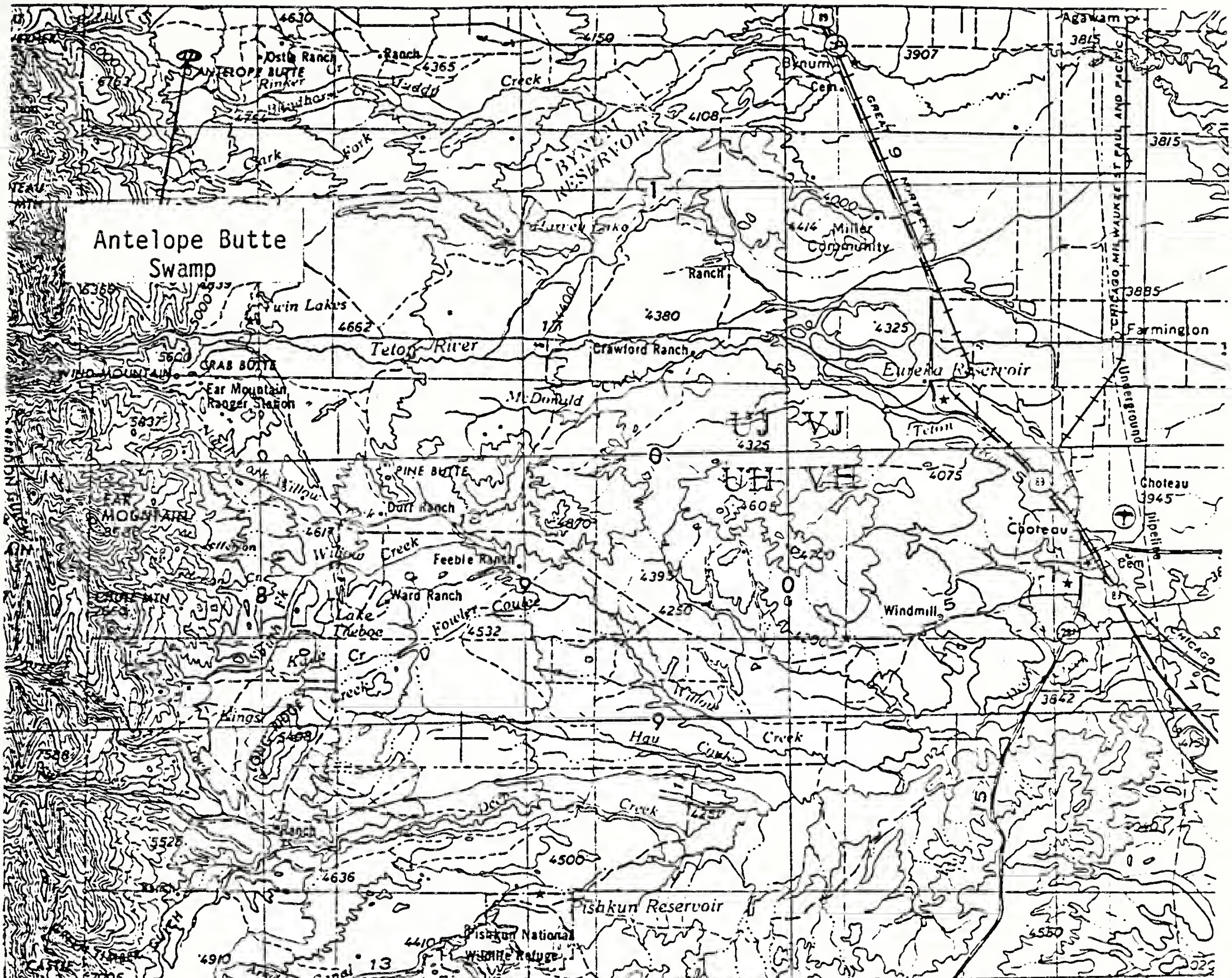
Olson, G.R. 1991. Kansas City here I come! Montana Outdoors. 22(3):19-22.

RECENT REPORTS:

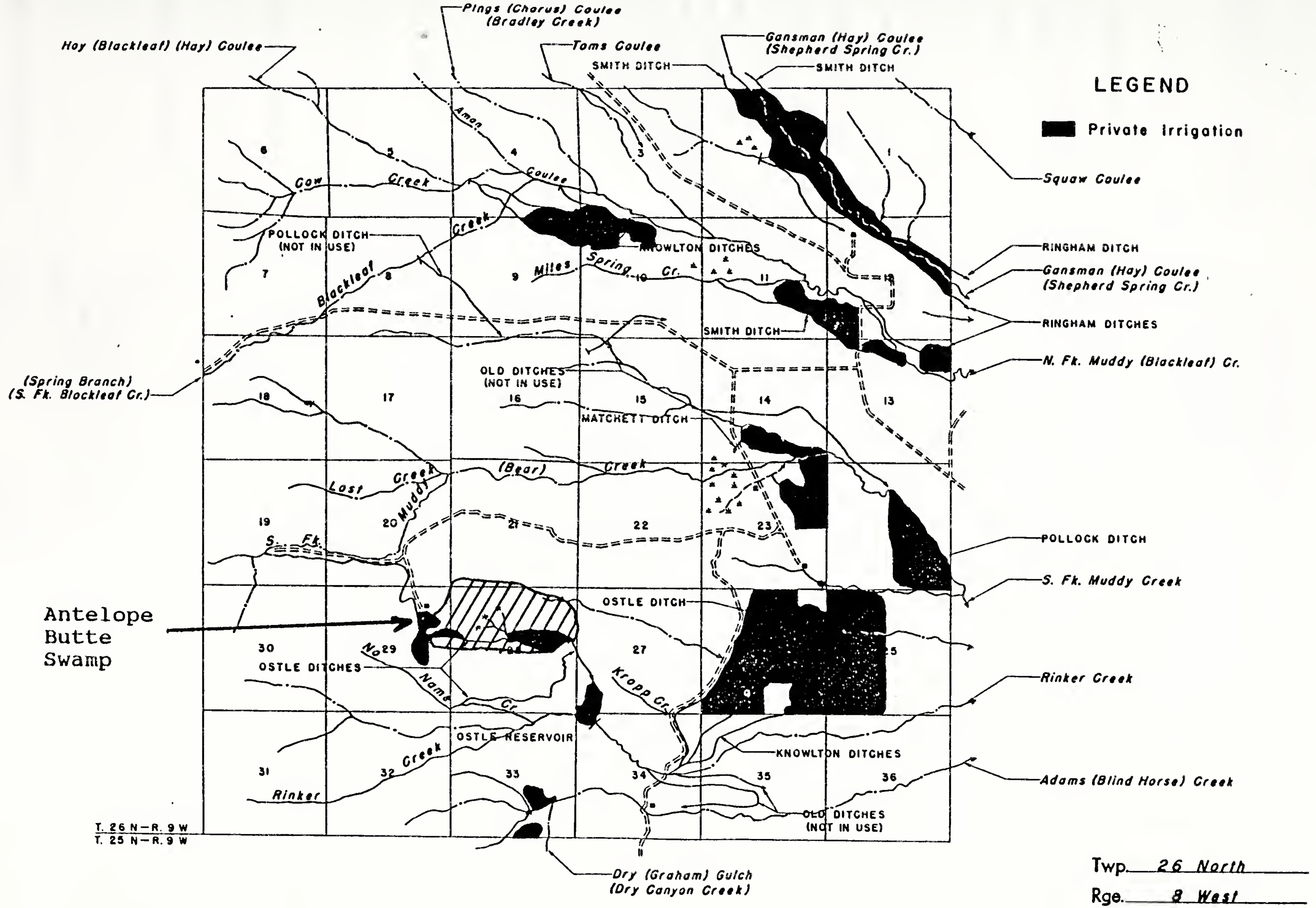
Olson, G.R. 1981. Effects of seismic exploration on summering elk in the Two Medicine-Badger Creek area, northcentral Montana. Big Game Survey and Inventory - Region Four. MT. Dept. Fish, Wildlife, and Parks. Job Progress Report. Project No. W-130-R-11. Job no. I-4. 27pp.

Olson, G.R. 1986. Tiber Reservoir mule deer monitoring and investigation. Big Game Survey and Inventory - Region Four. Mt. Dept. Fish, Wildlife, and Parks. Job Progress Report. Project no. W-130-R-17. Job no. I-4. 36pp.

Olson, G.R. 1991. Sweetgrass Hills elk monitoring project. Special report. Mt. Dept. Fish, Wildlife, and Parks, Helena, MT. 53pp.



Location map for Antelope Butte Swamp.



Antelope Butte Swamp and vicinity. (From Water Resources Survey, Teton County, 1962.)

Form No. 76-O R2/80

Blackleaf W.M.A.
R-4
4-28-82

S410-W-178032-00

STATEMENT OF CLAIM FOR EXISTING WATER RIGHTS

OTHER USES

For the Water Courts of the State of Montana

1. Owner of Water Right
MONTANA, STATE OF
DEPT OF FISH WLDLFE & PARK
1420 E 6TH
HELENA MT 59620
_______ / _______ Middle Initial

Co-Owner or Other Interest Owner _______ / _______ Middle Initial

Address ____________

City ____________ Zip Code ____________

Home Phone No. ________ Business Phone No. 449-3888

2. Person completing form Wipperman / Alfred / H.
Last / First / Middle Initial

Address Rural Route 4041, Dept. of Fish, Wildlife and Parks

City Great Falls State Montana Zip Code 59405

Home Phone No. ____________ Business Phone No. 454-3441

3. Use: (Check Only One)

FR ☐ Fish Raceways	GE ☐ Geothermal	MN ☐ Mining
FW ☒ Fish & Wildlife	NV ☐ Navigation	PG ☐ Power Generation
CM ☐ Commercial	FP ☐ Fire Protection	RC ☐ Recreation
IN ☐ Industrial	AS ☐ Agricultural Spraying	OT ☐ Other
MC ☐ Municipal	OF ☐ Oil Well Flooding	Explain ____________

4. Source of Water: (Check Only One)

☐ Spring Name ____________

☐ Well Name ____________

☐ Stream Name ____________ Tributary of ____________

☒ Lake Name Antelope Butte Swamp Stream ____________
Tributary of ____________

☐ Reservoir Name ____________ Stream ____________
Tributary of ____________

5. Point of Diversion: County Teton
____ ¼ ____ ¼ NE ¼, Section 28, T 26 [✓ N]/S, R 8 E/[✓ W]
Lot ______, Block ______, Subdivision ____________

6. Means of Diversion:
☐ Well
☐ Pump Capacity ____________ gpm
☐ Headgate with ditch or pipeline
☐ Instream use
☒ Other Explain Water to remain in swamp

7. Means of Conveyance:
☐ Ditch
☐ Pipeline
☐ Instream
☒ Other: Water to remain in swamp

8. Place of Use: County Teton

☐ Instream ☐ City or Town ☒ Other: Explain Water stored in swamp

Lot, Block, ¼ ¼ NE ¼, Section 28, T 26 [✓ N]/S, R 8 E/[✓ W]
Lot, Block, ¼ ¼ NW ¼, Section 28, T 26 [✓ N]/S, R 8 E/[✓ W]
Lot, Block, ¼ NE ¼ NE ¼, Section 29, T 26 [✓ N]/S, R 8 E/[✓ W]
Lot, Block, ¼ SE ¼ SE ¼, Section 20, T 26 [✓ N]/S, R 8 E/[✓ W]
Lot, Block, ¼ SE ¼ SE ¼, Section 21, T 26 [✓ N]/S, R 8 E/[✓ W]
Subdivision

9. Flow rate claimed: N/A ☐ cubic feet per second ☐ gallons per minute ☐ miner's inches

10. Volume claimed: 460 acre-feet per year (flow through, non-consumptive)

11. Period(s) of use: Jan. / 1 to Dec. / 31
Month Day Month Day

12. Check one:
☐ Decreed Water Right
☐ Filed Appropriation Right
☒ Use Water Right

Priority date or date of first use
/ Feb. / 26 / 1921
Hour Month Day Year

13. Attach copies of the Decree, Record of Filing or Proof of Use Right.

14. Attach copies of aerial photographs, U.S. Geological Survey maps or such other documents necessary to show point of diversion, place of use, place of storage, and conveyance facilities.

15. Notarized Statement signed by claimant.

STATE OF MONTANA)
:ss.
County of Teton)

I, Alfred H. Wipperman, having been duly sworn, depose and say that I, being of legal age and being the claimant of this claim of existing water right, and the person whose name is signed to it as the claimant, know the contents of this claim and the matters and things stated there are true and correct.

Alfred H Wipperman

Subscribed and sworn before me, this 27 day of April 19 [illegible].

Notary Public for the State of Montana

Residing at Great Falls
My Commission expires 9-23-84

Form No. 76-A-2

ADDENDUM TO STATEMENT OF CLAIM FOR EXISTING WATER RIGHTS

For the Water Courts of the State of Montana

ADDITIONAL POINT OF DIVERSION SHEET

Use this sheet if you have more than one point of diversion from a single source. List your primary point of diversion on the claim form.

03 County Teton
___ ¼ ___ ¼ NW ¼, Section 28, T 26 [✓ N]/S R 8 E/[✓ W]
Lot ___, Block ___, Subdivision ___

County Teton
___ ¼ NE ¼ NE ¼, Section 29, T 26 [✓ N]/S R 8 E/[✓ W]
Lot ___, Block ___, Subdivision ___

County Teton
___ ¼ SE ¼ SE ¼, Section 20, T 26 [✓ N]/S R 8 E/[✓ W]
Lot ___, Block ___, Subdivision ___

County Teton
___ ¼ SE ¼ SE ¼, Section 21, T 26 [✓ N]/S R 8 E/[✓ W]
Lot ___, Block ___, Subdivision ___

County Teton
___ ¼ SW ¼ SE ¼, Section 21, T 26 [✓ N]/S R 8 E/[✓ W]
Lot ___, Block ___, Subdivision ___

County Teton
___ ¼ SE ¼ SW ¼, Section 21, T 26 [✓ N]/S R 8 E/[✓ W]
Lot ___, Block ___, Subdivision ___

County Teton
___ ¼ SW ¼ SW ¼, Section 21, T 26 [✓ N]/S R 8 E/[✓ W]
Lot ___, Block ___, Subdivision ___

County ___
___ ¼ ___ ¼ ___ ¼, Section ___, T ___ N/S R ___ E/W
Lot ___, Block ___, Subdivision ___

Use additional sheets if necessary

Form No. 76 A 3

ADDENDUM TO STATEMENT OF CLAIM
FOR EXISTING WATER RIGHTS

For the Water Courts of the State of Montana

ADDITIONAL PLACE OF USE SHEET

Use this sheet if you have more places of use than can be listed on the claim form or if places of use are in different counties. Use the spaces on the claim form first.

County Teton Subdivision

Acres	Lot	Block	¼	SW ¼	SE ¼	Section 21	T 26	[✓ N]/S	R 8	E/[✓ W]
Acres	Lot	Block	¼	SE ¼	SW ¼	Section 21	T 26	[✓ N]/S	R 8	E/[✓ W]
Acres	Lot	Block	¼	SW ¼	SW ¼	Section 21	T 26	[✓ N]/S	R 8	E/[✓ W]
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W
Acres	Lot	Block	¼	¼	¼	Section	T	N/S	R	E/W

Use additional sheets if necessary

ATTACHMENT A

ANTELOPE BUTTE SWAMP

Antelope Butte Swamp covers approximately 240 acres and contains about 100 acres of open water. Water depths vary from 5 feet in several beaver dams to a few inches in marshy areas. Average depth of standing water is about one foot. Therefore, the swamp contains about 100 acre-feet of water. Average evaporation in the area is about 36 inches per year. The Department of Fish, Wildlife and Parks (DFWP) is claiming 100 acre-feet storage in the swamp plus 360 acre-feet evaporation, or a total of 460 acre-feet of water for fish and wildlife use.

The Antelope Butte Swamp lies within the Township the 1921 Legislature created as a game and bird preserve, which was known to be the "Blackleaf Preserve" (see Attachment B). The passage of the Act was effective February 26, 1921, and is the date the DFWP is claiming as priority of use. The DFWP purchased the Swamp and surrounding area, now known as the Blackleaf Game Range, in 1979.

The swamp area is defined as a lowland marsh characterized by wet sub-irrigated meadows on the perimeter with aspen and willow stands forming a margin between standing water and meadows. The wet meadows contain mainly sedges, rushes, fescues, bluegrass and timothy. The swamp interior is interspersed with rushes and sedges. Beaver dams and small ponds are abundant.

Grizzly and black bear forage in the swamp area during the early spring months before upland areas become green and lush. At least 17 individual grizzly bears were identified as using the area during an intensive study in 1980. Additionally, whitetail deer use the marsh intensively for cover and forage during all seasons of the year. Mule deer seek out shelter from severe winds during winter months and are frequently observed feeding in and around the interior of the area during early spring months. Elk have been observed feeding and resting in the heavy cover of willow and aspen. Sources for the above information are Department of Fish, Wildlife and Parks Big Game Surveys, Region Four Elk and Deer Progress Reports, 1970-1982. Grizzly data originates with several miscellaneous observations by Hamlin and Frisina, 1974, and Border Grizzly Project Annual Reports, 1977-1982.

Additional wildlife observed frequenting the swamp include furbearers such as muskrat, beaver, mink, bobcat, lynx and coyote. Various shorebirds, mallards and blue-winged teal nest in the area. A few raptors such as the golden eagle, marsh hawk and horned owls are occasionally observed.

Attachment B

CHAPTER 114.

AN ACT CREATING A GAME AND BIRD PRESERVE IN THE COUNTY OF TETON, STATE OF MONTANA.

Be It Enacted by the Legislative Assembly of the State of Montana:

Section 3773. That Township Twenty-six (26), North of Range Eight (8), West of the Montana Meridian, in Montana, be, and the same is hereby created a Game and Bird Preserve, to be known as the "Blackleaf Preserve," within the County of Teton, State of Montana, and it is hereby declared to be unlawful to hunt for, trap or kill, or cause to be hunted for, trapped or killed, or to trap, capture or molest any of the game animals or birds of any kind whatever within the limits of said Game and Bird Preserve hereby created, or to interfere with nests or eggs of such birds, or to carry or discharge any firearms, or to create any unusual disturbances tending to frighten or drive away any game animals or birds, or to chase the same with dogs or hounds within said preserve; provided, however, that permits to capture animals or birds for the purpose of propagation, or to destroy mountain lions, wolves, foxes, coyotes, wild cats, mink, or other predatory animals or birds, may be issued by the State Game Warden upon the payment of such license fee and in accordance with such regulations as now are or may be established for the administration of Game and Bird Preserves by the State Fish and Game Commission.

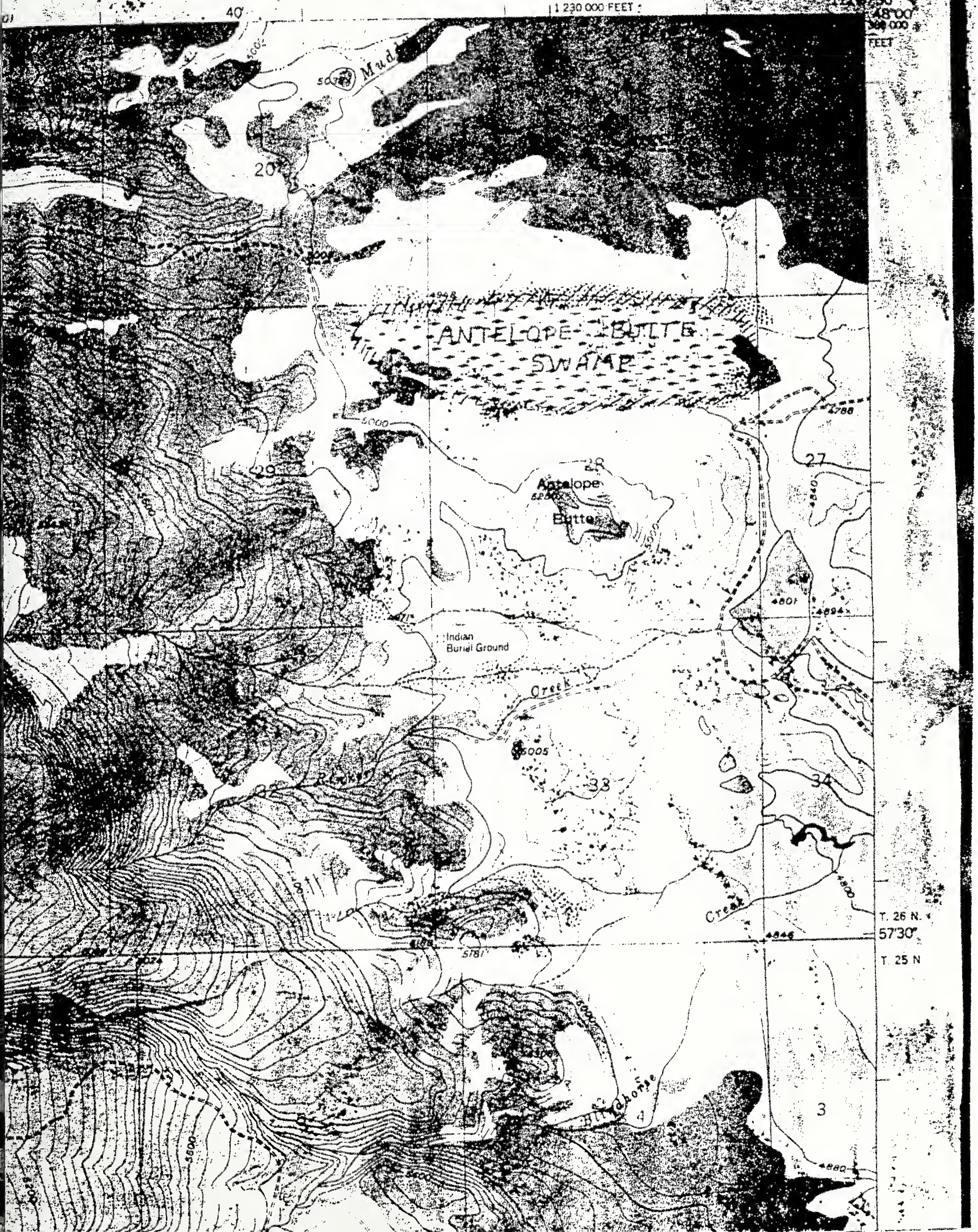
Section 3774. Any violation of any of the provisions of this Act shall be a misdemeanor, and upon conviction shall be punishable by a fine of not less than Twenty-five ($25.00) Dollars, nor more than Five Hundred ($500.00) Dollars, or by imprisonment in the county jail for not less than ten (10) days nor more than one hundred (100) days, or by both such fine and imprisonment.

This Act shall be in full force and effect from and after its passage and approval.

Approved February 26, 1921.

Falls

MONTANA–TETON CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



PREFILED DIRECT TESTIMONY
OF WILLIAM M. GARDNER ON BEHALF OF THE
MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. Please state your name and business address.

A. William M. Gardner, Montana Department of Fish, Wildlife and Parks, P.O. Box 1088, Fort Benton, MT 59442.

Q. What is your present employment?

A. I am a fisheries biologist employed by the Montana Department of Fish, Wildlife and Parks (MDFWP).

Q. Please state your educational and employment experience.

A. I received a B.S. in 1974 and a M.S. in 1977 both in Fish and Wildlife Management at Montana State University. I have been employed with the MDFWP from 1979 to the present. During my 13 years of employment with the MDFWP, I have worked on seven different projects. From 1979 to 1981, Mr. Rod Berg and I conducted an instream flow study on the wild and scenic portion of the Missouri River. The following year I assisted Mr. Berg with an instream flow study on the Missouri River between Holter Dam and Cascade, Montana. From 1989 to 1983, I conducted a one-year instream flow study related to the Marias River fishery near Tiber Dam. The next three years I spent completing a fisheries planning and inventory study on the lower Missouri River downstream of Fort Peck Dam. From 1986 to 1989, I surveyed 19 tributaries of the middle Missouri River basin and evaluated the fisheries values and instream flow requirements for these tributaries. Presently I am conducting a study to determine the population status of the pallid sturgeon in the Missouri River, and another study investigating the reproduction success of paddlefish in the Yellowstone River. Details of my work experience are included in the attached biography.

Q. What is your experience in studying instream flow requirements for fisheries?

A. During 12 years of employment with the MDFWP, I have been investigating instream flow requirements for various fisheries throughout Montana either as a primary or secondary study objective. I received technical training for collecting wetted perimeter data to be used in the Wetted Perimeter Inflection Point Method from Messrs. Fred Nelson and Rod Berg, MDFWP. I received training in stream flow measuring techniques from Mr. Ron Shields, U.S. Geological Survey. Also, I attended a three day instream flow methods workshop sponsored by OEA Research, a Helena consulting firm.

Q. What is the purpose of your testimony in this proceeding?

A. The purpose of my testimony is to support the MDFWP's instream flow requests for the 24 stream reaches that I was responsible for in the Department's application.

Q. What was your part in the preparation of the MDFWP's Missouri River Basin water reservation application?

A. I was involved with the collection and analyses of fisheries and wetted perimeter information on 24 streams or stream reaches in the Missouri River Basin. Additionally, I collected fisheries information in Reaches 3 - 6 of the Missouri River mainstem and assisted with the preparation of those portions of the application applicable to these reaches.

Q. Please list the 24 stream reaches that you were directly responsible for.

Beaver Creek (Big Spring Creek)
Belt Creek reaches 1 and 2
Big Otter Creek
Cottonwood Creek (Big Spring Creek)
Cow Creek
Dry Fork Belt Creek
East Fork Big Spring Creek
Highwood Creek
Judith River reaches 1 and 2
Logging Creek
Lost Fork Judith River
Marias River reaches 1, 2 and 3
Middle Fork Judith River
Pilgrim Creek
Shonkin Creek
South Fork Judith River
Sun River reaches 1 and 2
Tillinghast Creek
Yogo Creek

Maps showing the general location of these streams and stream reaches are attached and made a part of this testimony.

Q. What methods were used to derive the instream flow requests?

A. The Wetted Perimeter Inflection Point Method was used on all streams except Big Otter Creek where the Base Flow Method was used.

Q. Please describe the instream flows requested and the resource values to be protected for each stream reach.

A. The streams that I evaluated for instream flow reservations

are located, generally, in Central Montana. Streams are not nearly as numerous here as compared to the more western sections of the state, and, because of this, each stream is important for its fishery value and for the variety of other recreational opportunities it provides. These streams are located in the Upper Missouri, Middle Missouri and Marias/Teton subbasins. I will discuss the streams and the requested instream flow reservations and briefly summarize their resource value:

Upper Missouri Subbasin

Sun River #1. The flow request is from Diversion Dam to Elk Creek. A flow of 100 cfs year-round is requested. The present trout fishery is rated as fair and there has been a considerable amount of angler use over the years. This fishery has a very good potential for improvement if better summer flows could be maintained if water should become available in the future. The Sun River suffers chronic dewatering during the summer as a result of intensive water use for irrigation. During the summer, for the majority of years, streamflows are less than the requested flow.

Sun River #2. The flow request is from Elk Creek to the mouth. A flow of 130 cfs is requested year-round. The present fishery is rated as fair for the majority of this section, and there has been a considerable amount of angler use over the years. Similar dewatering problems affect this section as were mentioned above for Sun River #1.

Belt Creek #1. The flow request is from the headwaters to Big Otter Creek. A flow of 90 cfs is requested year-round. The present trout fishery is rated as very good although it would probably improve if the heavy metals pollution from abandoned mines upstream was controlled. The MDFWP stocks the lower portion of this section with 3,000 "catchable" size rainbow trout annually. This stream provides a considerable amount of fishing recreation. Normally occurring base flows in this section are probably less than the requested instream flow in some months due to natural geologic factors.

Belt Creek #2. The flow request is from Big Otter Creek to the Missouri River. A flow of 35 cfs is requested year-round. The present coldwater and warmwater fisheries values are rated as moderate, although the warmwater fishery has a good potential for improvement. Normally occurring base flows in this section are probably less than the requested instream flow in some months due to natural geologic causes.

Big Otter Creek. The flow request is from Whiskey Spring Coulee to Belt Creek. A flow of 5 cfs is requested year-round. The present trout fishery is rated as good, with exceptionally

large-size brown trout for a creek of this size. This small stream receives a considerable amount of angler use. Water availability appears adequate to meet the instream flow request in most months.

Dry Fork of Belt Creek. The flow request is from Galena and Oti Park creeks to Belt Creek. A flow of 7 cfs is requested year-round. The present trout fishery is severely depressed because of heavy metal pollution from abandoned mines. This stream has a good potential for improvement in the fishery once the pollution is abated. Water availability appears adequate to meet the instream flow request in most months.

Logging Creek. The flow request is from the headwaters to Belt Creek. A flow of 6 cfs is requested year-round. This stream has a very good trout fishery with a moderate amount of angler use. Water availability appears adequate to meet the instream flow request in most months.

Pilgrim Creek. The flow request is from the headwaters to Belt Creek. A flow of 8 cfs is requested year-round. Pilgrim Creek is a unique stream in this drainage because the trout population is comprised entirely of cutthroat trout. The numbers of cutthroat are very good and the fishery receives a moderate amount of angler use. Normally occurring base flows may be less than the requested instream flow in some months.

Tillinghast Creek. The flow request is from the headwaters to Belt Creek. A flow of 5.5 cfs is requested year-round. This stream has a very good trout fishery with a light amount of angler use. Water availability appears adequate to meet the instream flow request in most months.

Middle Missouri Subbasin

Cow Creek. The flow request is from the junction of the North and South forks to County bridge. A flow of 4.5 cfs is requested year-round. Cow Creek has an excellent trout fishery and fishing pressure is probably light. Normally occurring base flows are probably less than the requested instream flow in some months.

Highwood Creek. The flow request is from the headwaters to Hwy. 228 Bridge at Highwood. A flow of 10 cfs is requested year-round. Highwood Creek has an excellent trout fishery and fishing pressure is considerable. Normally occurring base flows are probably less than the requested instream flow in some months.

Shonkin Creek. The flow request is from the national forest boundary to Shonkin. A flow of 7 cfs is requested year-round. Shonkin Creek has an excellent trout fishery and fishing

pressure is moderate. Normally occurring base flows are probably less than the requested instream flow in some months.

Judith River #1. The flow request is from the junction of the South and Middle forks to Big Spring Creek. A flow of 25 cfs is requested year-round. This section of the Judith River has a very good trout fishery that receives a considerable amount of angler use. Large brown trout are found in this section during the fall spawning season. Normally occurring base flows in this section are probably less than the requested instream flow in some months.

Judith River #2. The flow request is from Big Spring Creek to the Missouri River. A flow of 160 cfs is requested year-round. This section of the Judith River has a fair fishery for both warmwater and coldwater species. The Judith River is an important spawning tributary for Missouri River channel catfish. Angler use on this section of the Judith is light. Water is available to meet the instream flow request in most months.

Beaver Creek. The flow request is from the West Fork to Cottonwood Creek. A flow of 5 cfs is requested year-round. This stream has a moderate trout fishery with a good potential for improvement with the introduction of warmwater fish species such as smallmouth bass. Angler use here is probably light. Water is available to meet the instream flow request in most months.

Cottonwood Creek. The flow request is from Spring Branch to Big Spring Creek. A flow of 4.5 cfs is requested year-round. Cottonwood Creek has a good trout fishery and angler use is probably light. The MDFWP stocks this stream with 500 "catchable" size rainbow trout annually. Normally occurring base flows in Cottonwood Creek are probably less than the requested instream flow in some months.

East Fork Big Spring Creek. The flow request is from the headwaters to Big Spring Creek. A flow of 7.5 cfs is requested year-round. The East Fork has a moderate trout fishery with a good potential for improvement in the downstream areas. Angler use on the East Fork is moderate. Normally occurring base flows here are probably less than the requested instream flow in some months.

Lost Fork of Judith River. The flow request is from the junction of the South and West forks to the Middle Fork of the Judith River. A flow of 14 cfs is requested year-round. The Lost Fork has a good trout fishery and angler use is probably light. Normally occurring base flows in this stream are probably less than the requested instream flow in some months.

Middle Fork of Judith River. The flow request is from the headwaters to the South Fork of the Judith River. A flow of 22 cfs is requested year-round. A fair trout fishery exists in the Middle Fork and angler use is rated as moderate. Normally occurring base flows in this stream are probably less than the requested instream flow in some months.

South Fork of Judith River. - The flow request is from the headwaters to Middle Fork. A flow of 3.5 cfs is requested year-round. This stream has a fair trout fishery that receives a considerable amount of angler use. The MDFWP stocks the South Fork with 500 "catchable" rainbow trout annually. Water appears to be available to meet the instream flow request in most months except the lowermost two miles loses water from natural geologic causes.

Yogo Creek. The flow request is from the headwaters to the Middle Fork of the Judith River. A flow of 3 cfs is requested year-round. Yogo Creek has a very good trout fishery and angler use is light. Water appears to be available in most years for a majority of the reach.

Teton/Marias Subbasin.

Marias River #1. - The flow request is from the junction of Two Medicine River and Cutbank Creek to the head of Tiber Reservoir. A flow of 200 cfs is requested year-round. This section of the Marias has a fair warmwater fishery with a good potential for improvement through reintroduction of a warmwater game fish that could take advantage of the good forage base in the stream. This section of stream is important for spawning by walleye from Tiber Reservoir. Angler use here is moderate. Water appears to be available in most months to meet the instream flow request.

Marias River #2. The flow request is from Tiber Dam to Circle Bridge (Hwy 223). A flow of 500 cfs is requested year-round. This section of the Marias is a 21-mile coldwater trout fishery that produces trophy size brown trout. Deep, cold water releases from Tiber Dam provide conditions that are favorable for rainbow and brown trout. Stream trout fisheries are uncommon in northcentral Montana, and, therefore, this one is of special value. Water availability is adequate in most years to meet the instream flow request.

Marias River #3. The flow request is from Circle Bridge to the mouth. A flow of 560 cfs is requested year-round. This lower section of the Marias has an excellent resident and migratory warmwater fishery. Resident species include sauger, walleye, channel catfish and smallmouth bass. Important migratory species from the Missouri River include shovelnose sturgeon, blue sucker, walleye, sauger and channel catfish.

The central location of this warmwater fishery makes it especially attractive for residents of the western part of the state where trout fishing is the major fishing activity.

William M. Gardner, being duly sworn, states that the foregoing testimony is true.

DATED this 30 day of October, 1991.

William M. Gardner
William M. Gardner

Subscribed and sworn before me this 30th day of October, 1991.

(NOTARY SEAL)

Debra A. [illegible]
Notary Public for the State of Montana
residing at Montana
My commission expires ______________

BIOGRAPHY
WILLIAM M. GARDNER
October 1991

PERSONAL:

Born August 9, 1952, Ashland, Wisconsin
Social Security No. 374-54-7833

EDUCATION:

B.S. Fish and Wildlife Mgmt., Montana State University, 1974.
M.S. Fish and Wildlife Mgmt., Montana State University, 1977.

EXPERIENCE:

1989 to present. MDFWP. Fort Benton. Fishery Biologist. Conducting a study to determine the population status of the pallid sturgeon in the Missouri River. Monitor movements of pallids using radio telemetry techniques and sample for pallids using trammel nets to determine distribution and abundance and habitat use. I am also conducting a paddlefish reproduction study in the Yellowstone River. Paddlefish spawning areas and timing of spawning is being studied by sampling the fry with plankton nets.

1986 to 1989. MDFWP. Fort Benton. Fishery Biologist. Assisted with determining the instream flow requirements for important fisheries in the Missouri River basin. Collected fisheries information on 19 streams in the basin and determined the instream flow requirements using the wetted perimeter and base flow methodologies.

1983 to 1986. MDFWP. Fort Peck. Fishery Biologist. Completed the lower Missouri River fisheries study began earlier. Monitored paddlefish spawning movements, completed fisheries sampling for determining distribution and abundance of the species found in the study area, conducted an inventory study of aquatic insect communities, determined instream flow requirements for maintaining riffles, side channels and sauger spawning habitat, and completed final report.

1982 to 1983. MDFWP. Chester. Fishery Biologist. Conducted the Marias River instream flow study. Responsibilities included study design and implementation of a research project that assessed the instream flow requirements for the existing fisheries. Conducted mountain whitefish population estimates, investigated the

life histories of the resident trout populations, determined the distribution and abundance of resident fish species, conducted an aquatic insect study and evaluated the fisheries instream flow requirements using the wetted perimeter inflection point methodology and completed the final report.

1981 to 1982. MDFWP. Cascade. Fishery Biologist. Assisted with field data collection for the upper Missouri River fisheries study. Conducted trout population estimates, investigated young-of-year trout habitat use, monitored trout spawning in tributary streams, and completed an inventory study of the aquatic insect communities in the study area.

1979 to 1981. MDFWP. Fort Benton. Fishery Biologist. Conducted the Wild and Scenic Missouri River instream flow study. Responsibilities included design and implementation of a fisheries research project assessing instream flow requirements for the existing fisheries. The importance of side channel areas was investigated, paddlefish spawning migration was monitored using radio telemetry techniques, the ecology of several fish species found in the study area was studied, and the final report was completed.

REPORTS:

Gardner, W. M. and R. K. Berg. 1982. An analysis of instream flow requirements for selected fishes in the wild and scenic portion of the Missouri River. Mont. Dept. of Fish Wildlife and Parks. Helena. 111p.

Gardner, W. M. and R. K. Berg. 1983. Instream flow requirements for the Marias River fishery downstream of Tiber Dam. Mont. Dept. of Fish Wildlife and Parks. Helena. 82p.

Gardner, W. M. and P. A. Stewart. 1987. The fishery of the lower Missouri River, Montana. Fed. Aid to Fish and Wildlf. Rest. Proj. FW-2-R. Job Ia. Mont. Dept. of Fish Wildlife and Parks. Helena. 224p.

Gardner, W. M. 1986-87. Middle Missouri River Basin - instream flow studies. Fed. Aid to Fish and Wildlf. Rest. Proj. FW-2-R 15 and 16. Job Ib. Mont. Dept of Fish Wildlife and Parks. Helena.

Gardner, W. M. 1988-89. Middle Missouri River Basin - instream flow studies. Fed. Aid to Fish and Wildlf. Rest. Proj. F-38-R. Job II. Mont. Dept of Fish Wildlife

and Parks. Helena.

Gardner, W. M. 1990-91. Missouri River pallid sturgeon inventory. Fed. Aid to Fish and Wildlf. Rest. Proj. F-46-R. Study III, Job D. Mont. Dept of Fish Wildlife and Parks. Helena.

Gardner, W. M. 1990-91. Yellowstone River paddlefish spawning study. Fed. Aid to Fish and Wildlf. Rest. Proj. F-46-R. Study III, Job E.

PAPERS PRESENTED

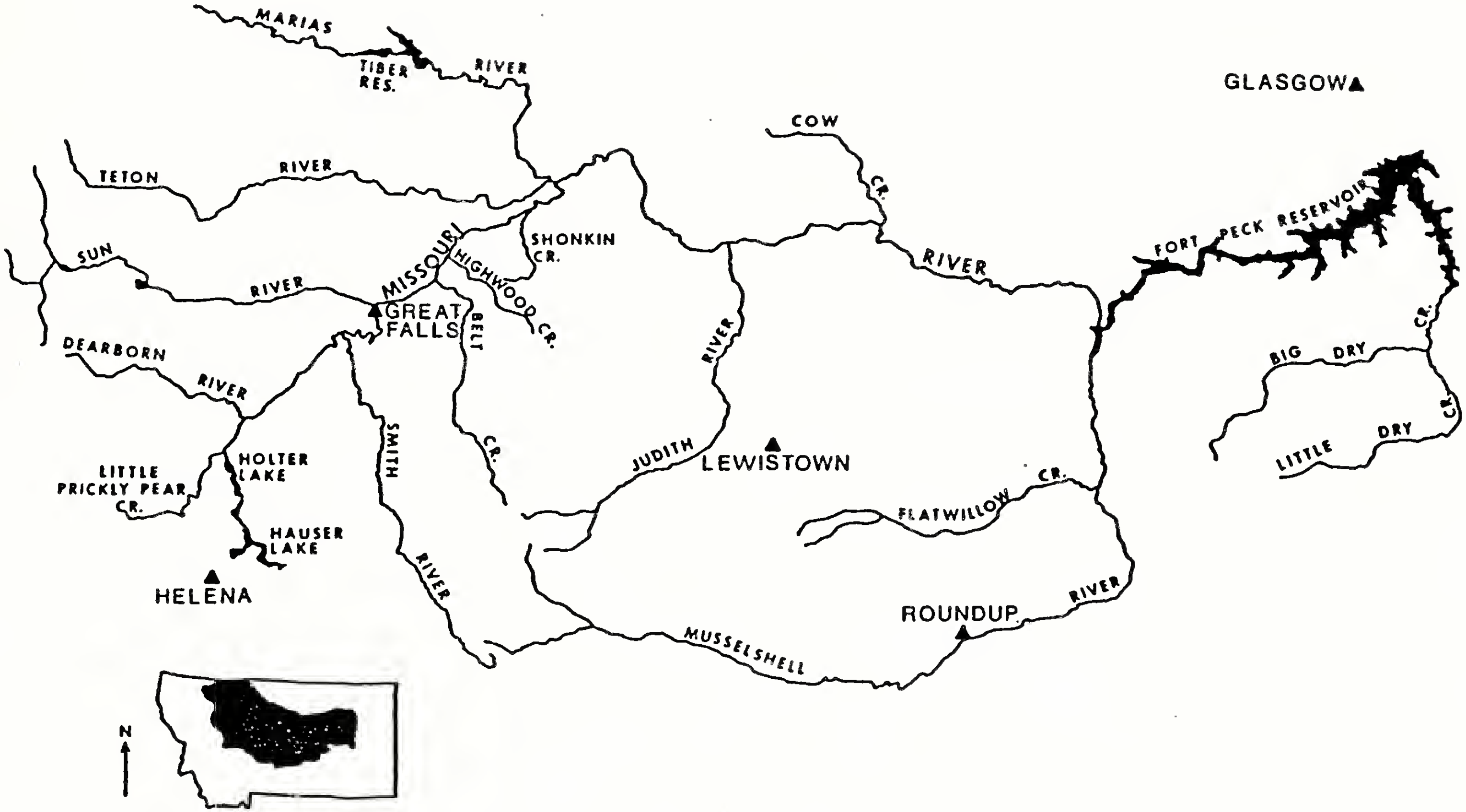
Great Plains Fishery Workers Assoc. (Lewistown, MT, February, 1988) Status of the paddlefish in the Missouri River, Montana.

Montana Chapter American Fisheries Society, (Bozeman, MT, March, 1987) Status of the paddlefish and pallid sturgeon in Montana.

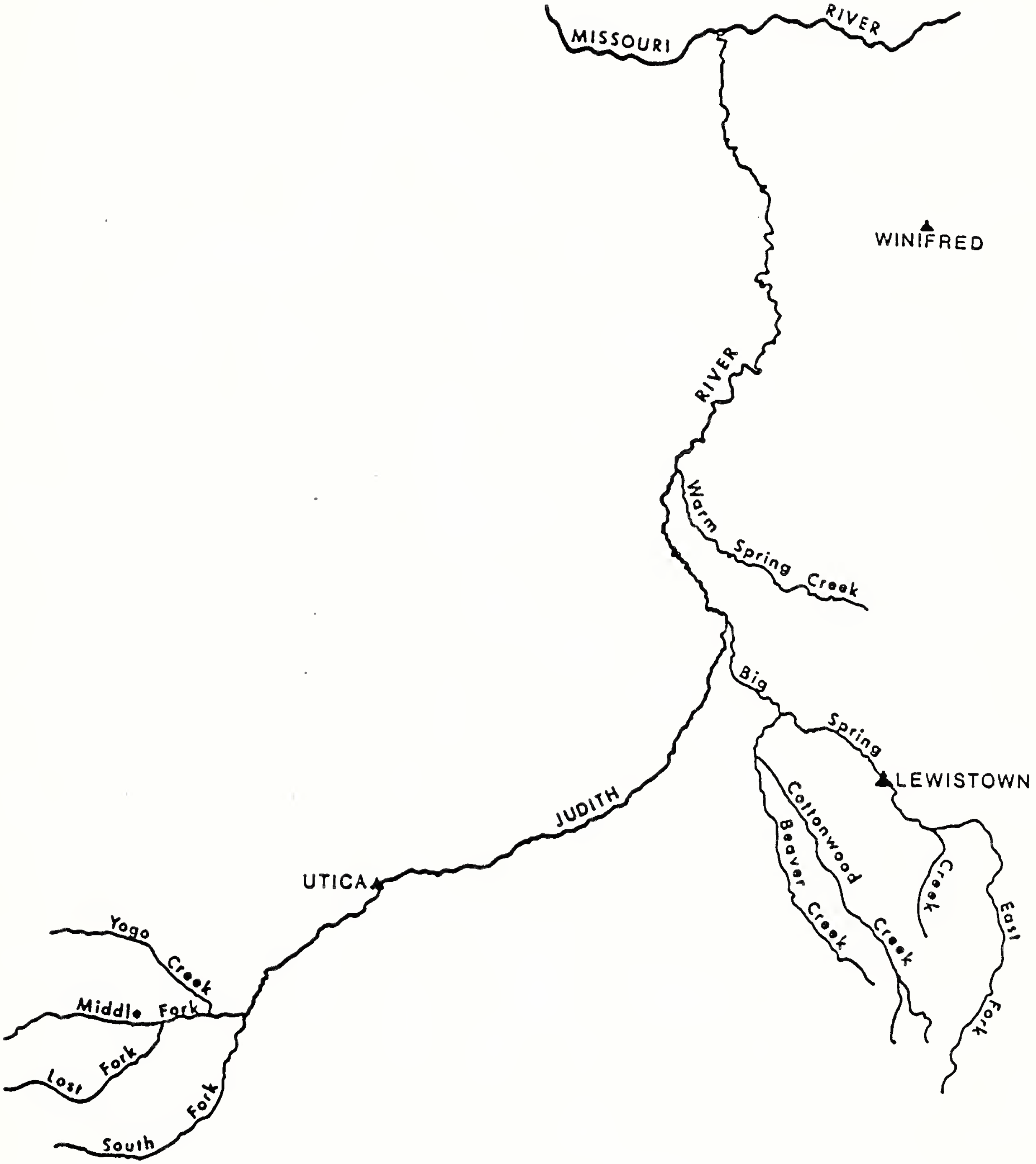
Great Plains Fishery Workers Assoc. (Ft. Collins, CO, February, 1987) Instream flow evaluations for the sauger fishery in the lower Missouri River, Montana.

Great Plains Fishery Workers Assoc. (Rapid City, SD, February, 1985) The occurrence of large shovelnose sturgeon in the middle Missouri River, Montana.

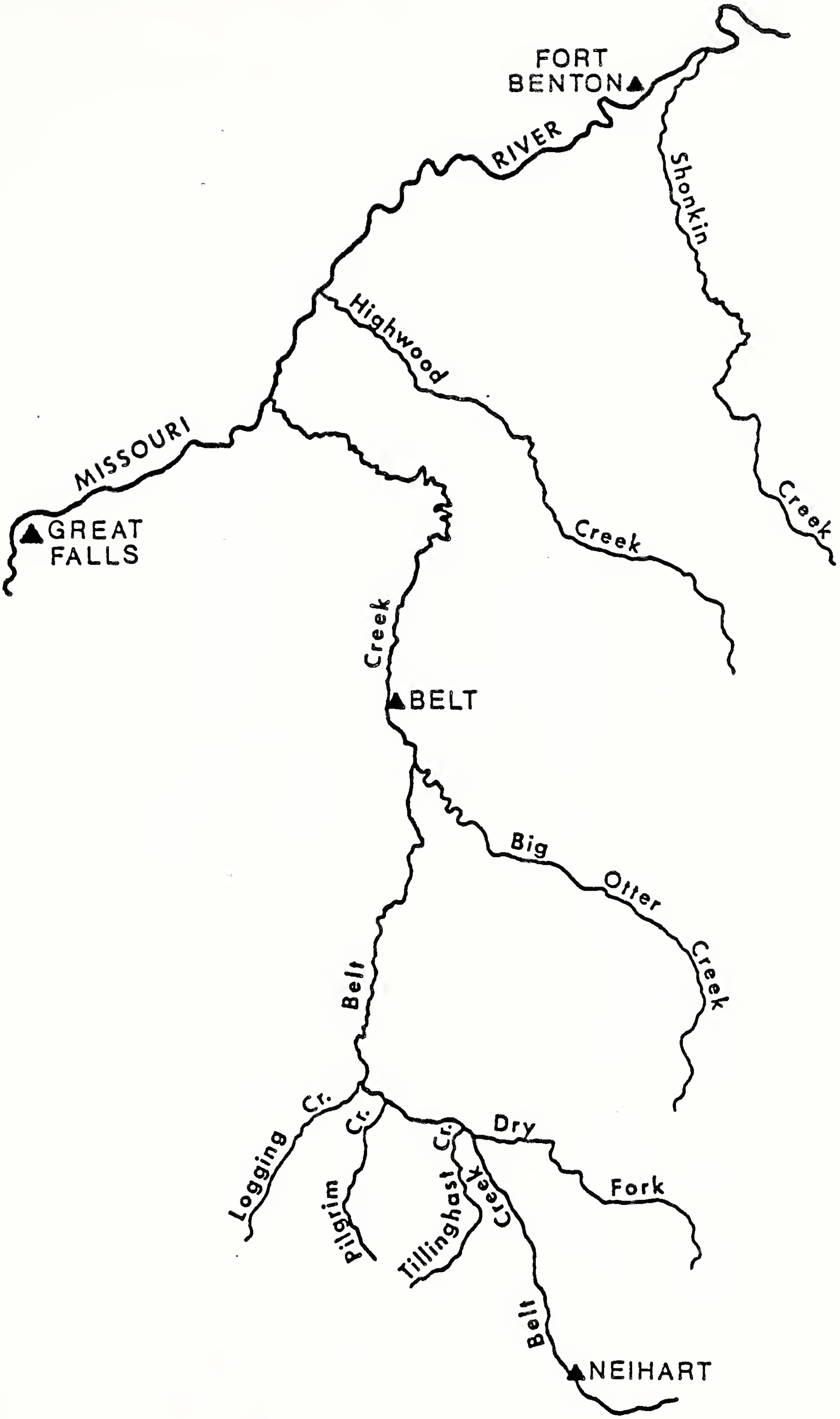
Appendix A



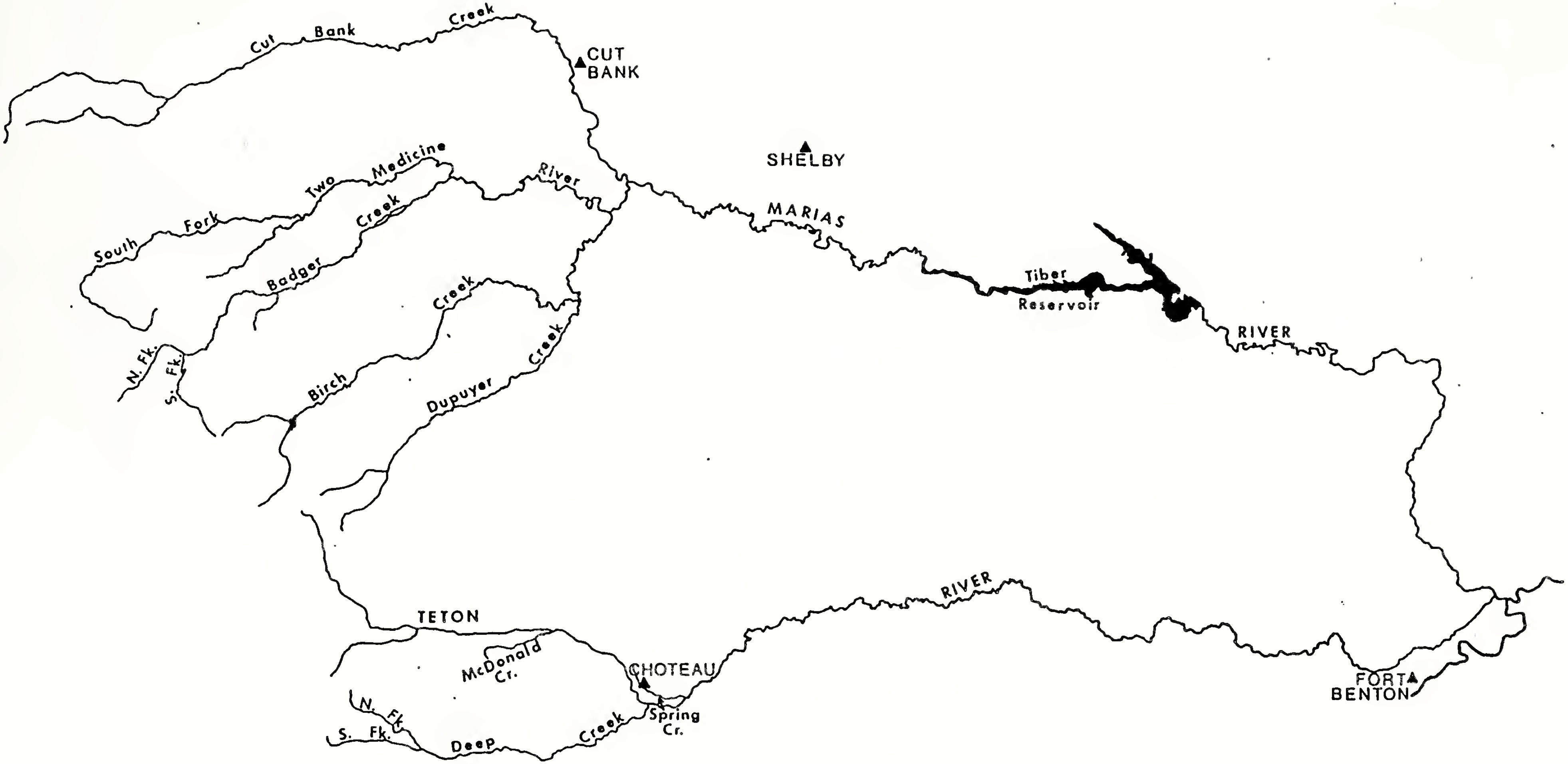
Map of the Missouri River Basin from Canyon Ferry Dam to Fort Peck Dam.



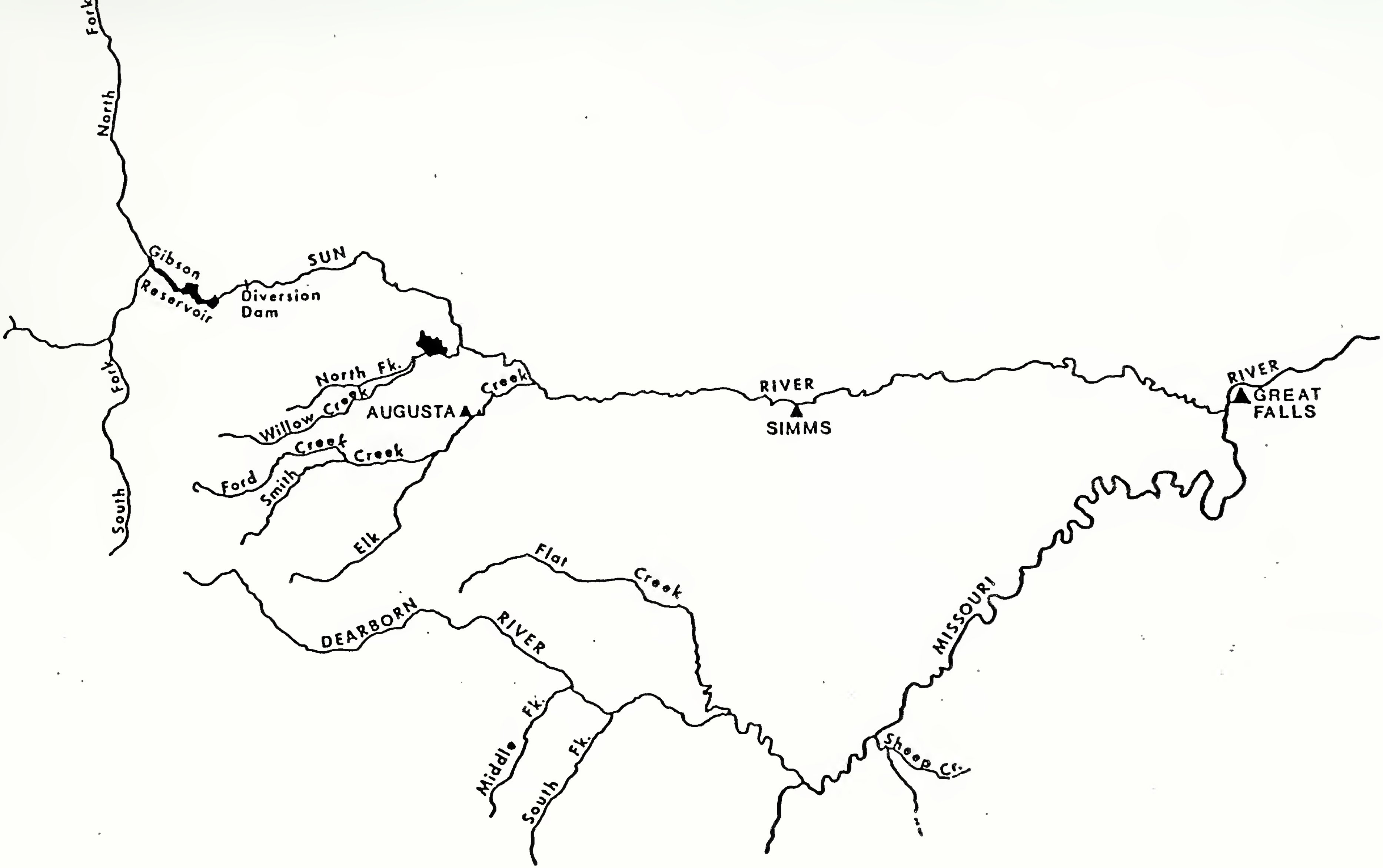
Location Map for the Judith River Drainage.



Location map for the Belt Creek drainage, Highwood and Shonkin Creeks.



Location map for the Marias River Drainage.



Map locating the Sun River Drainage.

PRE-FILED TESTIMONY OF BILL HILL
ON BEHALF OF THE MONTANA DEPARTMENT
OF FISH, WILDLIFE AND PARKS (MDFWP)

Q. What is your name and address?

A. Bill Hill, Box 296, Choteau, Montana 59422

Q. What is your occupation and by whom are you employed?

A. I am a Fisheries Biologist employed by the Montana Department of Fish, Wildlife & Parks.

Q. In what area do you work and what are your job responsibilities?

A. I work in the north and west portions of DFWP Region Four, which includes the Sun River, Teton River and Marias River drainages. I am responsible for the inventory and survey of the streams and lakes within these drainages and for making recommendations for the fisheries management of these waters.

Q. What is your educational background?

A. I obtained B.S. and M.S. degrees in 1963 and 1965, respectively, in Fish and Wildlife Management from Montana State University. My M.S. thesis involved the life history of goldeye in Montana. Post-graduate education includes: a short course in Stream Mechanics and Fisheries from Montana State University in 1982; and a workshop on determining stream flow/stream profile information sponsored by the U.S. Geological Survey (USGS) and the Montana Department of Fish, Wildlife & Parks in 1986.

Q. What is your employment experience?

A. I worked as a Fisheries Biologist for the North Dakota Game & Fish Department from 1965-1969. Since 1969, I have worked for MDFWP as a Fisheries Biologist, stationed in Choteau.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to provide supporting documentation for the water reservation requests on the streams for which I was responsible.

Q. What portion of the Department's application covers material that is supported by your testimony?

A. My testimony involves 19 streams contained in Volume 3, pages 3-198 to 3-209 and pages 3-265 to 3-312 of the application.

Q. What streams will you discuss in your testimony?

A.

North Fork Willow Creek	Sun River Drainage P. 3-198 to 3-209
Willow Creek	
Ford Creek	
Elk Creek	
Birch Creek	Marias River Drainage P. 3-265 to 3-291
So. Fork Dupuyer Creek	
No. Fork Dupuyer Creek	
Dupuyer Creek	
So. Badger Creek	
No. Badger Creek	
Badger Creek	
So. Fork Two Medicine River	
Cut Bank Creek	
Teton River	Teton River Drainage P. 3-292 to 3-312
McDonald Creek	
So. Fork Deep Creek	
No. Fork Deep Creek	
Deep Creek	
Spring Creek	

Maps showing the general location of these streams are attached and are a part of my testimony.

Q. What are your qualifications regarding instream flow analysis?

A. I participated in field training and workshops on streamflow measurement and the wetted perimeter method sponsored by the DFWP and U.S. Geological Survey. Knowledge gained in this training included the technique of measuring streamflows under field conditions, measuring stream profiles and interpreting the information produced by the wetted perimeter computer program. Assistance in collecting and interpreting the information on the field streams I am testifying to was also obtained from Fred Nelson, as needed.

Q. What methods were used to determine flows for the requested reservations on these 19 streams?

A. As stated later in my testimony for each stream, the wetted perimeter method was used on 11 streams, the base flow method on 3 streams and the fixed percentage method on 5 streams. These methods are explained in Fred Nelson's testimony and in Volume 1 of the DFWP application.

Q. Did you personally collect all of the biological flow and stream profile information for these streams?

A. I collected the majority of the information. Some fish population data were obtained from MDFWP files and U.S. Forest Service surveys. Due to access problems on some streams, stream flow and profile measurements used in the wetted perimeter analysis were not made. Instead, the fixed percentage and base flow methods were used on these streams. These methods are explained in the testimony by Fred Nelson.

Q. Has any new data been collected since the application was filed?

A. Yes. This data was collected in 1990 and 1991 and will be discussed for the individual streams where it is available.

Q. You stated that you are a fisheries biologist. How can you testify to the information on grizzly bear and other wildlife using the streams you discuss?

A. Observations on wildlife species were made by me while visiting the streams. Other information was obtained by contacting the local DFWP wildlife biologist. In addition, grizzly bear information was obtained from DFWP biologists whose job is working directly with this species.

Q. What are the resource values of the streams that you will discuss in your testimony?

A. The 19 streams that I discuss in my testimony have many important values. The main objective of the reservations is to maintain habitat and, therefore, the existing trout fisheries of these waters. To maintain these fisheries, certain habitat requirements are necessary. These include: adequate flows, good water quality; food producing areas; spawning and rearing areas; and stable channels and stream banks.

The fisheries in these 19 streams are important to people of the local area. In some cases, an individual stream is the only trout fishery available to anglers for many miles around. In others, a particular species or large-sized fish may be unique to that geographic area.

A high percentage of the streams for which I present testimony contain westslope cutthroat trout. I feel that it is important to maintain this species because it is a "species of special concern" (George Holton, Montana Outdoors, Mar/Apr 1986).

Q. Why is the westslope cutthroat trout considered a "species of special concern"?

A. At the time of the 1805 Lewis and Clark expedition, the westslope cutthroat was native to the Missouri River drainage above Great Falls according to Dr. C.J.D. Brown in his book Fishes of Montana, 1971. The species presently occurs only as relict populations in very few streams east of the Continental Divide. The Montana Chapter of the American Fisheries Society had designated the westslope cutthroat to be a "species of special concern". This designation reflects the limited numbers of these native fish present in the state and/or the limited amount of preferred habitat still available to them. They have been eliminated or severely reduced in numbers over much of their former range. The species depends on relatively pristine habitat and a low level of competition from non-native fishes for their survival. Instream flow reservations would help maintain a vital component of the habitat still available for their existence.

Ten of the 19 streams I discuss either have pure westslope cutthroat populations (as determined by genetic testing) or have the habitat potential for this species. The species is unique and should be protected in this area because of its occurrence in very limited numbers in a few headwater streams along the east front of the Rocky Mountains. The westslope cutthroat needs all of the help it can get to maintain its existence.

Q: What other resource values do these streams provide?

A: Several streams or portions of streams have significant scenic values and a few have extremely high pristine characteristics. Streams which have pristine qualities include South Badger Creek, North Badger Creek, Badger Creek and South Fork Two Medicine River. Adequate flows are a very important ingredient in maintaining these qualities. Sufficient flows will also benefit the riparian areas of all these streams. Riparian areas provide the necessary habitat for many wildlife species, including the threatened grizzly bear which frequents many of the 19 streams I discuss. Specific information on these streams is given below.

North Fork Willow Creek - From the headwaters to the mouth, approximately 10.5 miles. This stream has a relatively stable flow pattern. The base flow method was used on this stream to determine a request of 3.0 cfs from January 1 to December 31, for a total of 2,172 acre-feet per year. Brook trout inhabit this stream and provide a good fishery to people of the local area. Flows are necessary to maintain the trout population and the riparian area, which is important to several wildlife species. The grizzly bear, a threatened species, uses the riparian area during spring, summer and fall.

Willow Creek - From the headwaters to the mouth, 15 miles. Brook trout are most abundant with some rainbow trout also present. Cutthroat trout were collected from the upper reaches in 1991. Preliminary testing by Dr. Robb Leary (U of M) indicates these fish to be pure westslope cutthroat. The wetted perimeter method was used to determine a request of 3.0 cfs or 2,172 acre-feet from January 1 to December 31. Portions of the stream experience low flows as a result of irrigation withdrawals. The flows are considered necessary to maintain habitat for westslope cutthroat trout, a species of special concern. The flows will also maintain the other trout populations, as well as the riparian area upon which wildlife species are dependent. The riparian area is important for the grizzly bear, a threatened species, which uses the stream as a travel corridor in spring, summer and fall.

Ford Creek - From the headwaters to the mouth, 12 miles. This stream supports an excellent brook trout population and is an important fishery in the area. Rainbow trout and cutthroat trout (undesignated) occur in fewer numbers. A flow of 12 cfs (8,688 acre-feet) is requested from January 1 to December 31, as determined by the wetted perimeter method. Lower portions of the stream have low flows in some years due to irrigation withdrawals. Flows are necessary to maintain the trout populations and the riparian area. The riparian area provides habitat for several wildlife species and the grizzly bear which uses the area during spring, summer and fall.

Elk Creek - From the headwaters to the mouth, approximately 25 miles. This stream has one of the most important trout fisheries in the Augusta area, and includes rainbow, brown and brook trout. The wetted perimeter method was used to request a flow of 16 cfs or 11,583 acre-feet from January 1 to December 31. Lower portions of the reach become dewatered in some years. The requested flows are necessary to maintain a locally important trout fishery. Wildlife species using the riparian area would also benefit from these flows. The grizzly bear is dependent on the riparian area during spring, summer and fall.

Birch Creek - From Swift Reservoir to Highway 358, approximately 43 miles. The fixed percentage method was used on this stream for a request of 64 cfs (46,334 acre-feet) from January 1 to December 31. Flows are limited in portions of the reach during some years primarily due to irrigation. The flows are necessary to sustain the existing trout fishery composed of brook trout, rainbow trout and mountain whitefish. The flows will also help maintain the riparian area which will benefit several wildlife species, including grizzly bear. This species uses the upper portion of the reach during spring, summer and fall.

South Fork Dupuyer Creek - From the headwaters to the mouth, six miles. Westslope cutthroat trout occur in the upper portions of the reach while cutthroat and brook trout occur in

the lower portions. Cutthroat were collected in 1991 and are presently being tested by Dr. Robb Leary (U of M) to determine genetic purity. A flow of 6 cfs or 4,344 acre-feet is requested for this stream from January 1 to December 31. The wetted perimeter method was used. This stream generally has good flows throughout the reach. The requested flows are necessary to maintain the existing trout habitat, especially the westslope cutthroat trout, a "species of special concern". The flows would also help maintain the riparian area, which is important for several wildlife species, particularly the grizzly bear, which uses the upper portions of the reach during spring, summer and fall.

North Fork Dupuyer Creek - From the headwaters to the mouth, six miles. The wetted perimeter method was used to determine a request of 12 cfs (8,688 acre-feet) from January 1 to December 31. Low to no flow is experienced in the lower portions in some years, but the upper part of the reach generally has adequate water. This stream contains westslope cutthroat and brook trout. The flows requested are necessary to maintain habitat for the existing trout populations, especially westslope cutthroat, a "species of special concern". Wildlife species would also benefit from these flows that would help maintain the riparian area. The grizzly bear, a threatened species, uses the riparian area during spring, summer and fall.

Dupuyer Creek - From the headwaters to the mouth, 32 miles. This stream is a valuable fishery in the Dupuyer area. It contains rainbow trout, brook trout and mountain whitefish. Portions of the reach are dewatered for irrigation in some years. A flow of 12 cfs (8,688 acre-feet) from January 1 - December 31 was determined by the wetted perimeter method. The flow request is necessary to maintain habitat for the existing trout populations. The flows would help maintain a riparian area and benefit several wildlife species. The threatened grizzly bear uses the stream corridor during spring and fall.

South Badger Creek - From the headwaters to the mouth, eight miles. This stream supports westslope cutthroat, brook and rainbow trout. The latter species occurs only in the lower ½ miles of the reach, below a barrier. A sample of cutthroat trout were genetically tested in 1990 and additional fish were collected in 1991. Preliminary analysis by Dr. Robb Leary (U of M) indicates these fish to be genetically pure westslope cutthroat trout. This stream has good flows throughout the year. Flows necessary to sustain the fishery were determined by the wetted perimeter method. A flow of 40 cfs or 28,959 acre-feet is requested from January 1 to December 31. Flows are necessary to maintain habitat for the westslope cutthroat, a "species of special concern". The flow will also assist in maintaining the riparian area for wildlife species, including the threatened grizzly bear during the spring, summer and fall periods.

North Badger Creek - From the headwaters to the mouth, eight miles. This stream is very important because the only species present is genetically pure westslope cutthroat trout, a "species of special concern". Barriers on the stream prevent other species from invading the area. The wetted perimeter method was used in determining a flow request. Flows of 14 cfs (10,136 acre-feet) are requested from January 1 to December 31. This stream has good flows throughout the year. The flows are necessary to maintain habitat for the westslope cutthroat trout. The riparian area will also be maintained and provide habitat for several wildlife species, especially the threatened grizzly bear, which uses the area during spring, summer and fall.

Badger Creek - From the confluence of North and South Badger Creeks to the national forest/Blackfeet Indian Reservation boundary, 6.5 miles. The fixed percentage method was used to determine the flow request of 60 cfs (43,438 acre-feet) from January 1 to December 31. Flows on this stream are good throughout the year. Surveys by the U.S. Forest Service in 1991 show cutthroat to be the most common fish present. A few rainbow and brook trout may also occur, based on past fishermen reports. A sample of cutthroat collected in 1991 are presently being tested for genetic purity by Dr. Robb Leary (U of M). Cutthroat in this stream are being treated as genetically pure westslope cutthroat due to their presence in both North and South Badger Creeks. Flows requested are necessary to protect habitat for westslope cutthroat, a "species of special concern". Habitat will also be maintained for the threatened grizzly bear, which uses the area during spring, summer and fall. Other wildlife species will also benefit.

South Fork Two Medicine River - From the headwaters to the national forest/Blackfeet Indian Reservation boundary, 15.5 miles. This stream is important because genetically pure westslope cutthroat occur in the upper portion of the reach. Cutthroat, rainbow trout and mountain whitefish occur in the lower portion. The wetted perimeter method was used to calculate a request of 16 cfs (11,583 acre-feet) from January 1 to December 31. Naturally-occurring low streamflows exist in portions of the reach in some years. Flows are necessary to maintain habitat for the westslope cutthroat, a "species of special concern". Riparian habitat will also be maintained for several wildlife species. The grizzly bear, a threatened species, uses the corridor during spring, summer and fall.

Cut Bank Creek - From the Blackfeet Indian Reservation boundary to the mouth, 19 miles. This stream is important to people in the Cut Bank area as it is the only trout stream readily available. Game fish include rainbow and brown trout, mountain whitefish and burbot. A few rainbow trout are stocked to supplement wild fish. The fixed percentage method determined a flow request of 75 cfs (54,297 acre-feet) from January 1 to December 31. Low flows occur periodically from

irrigation withdrawals upstream. Flows are necessary to maintain the existing trout fishery.

Teton River - From the headwaters to the discharge from Priest Butte Lake near Choteau, 33 miles. Game fish in the reach include brook, brown and rainbow trout and mountain whitefish. The latter three species provide a significant fishery in the lower portion of the reach. Portions of the reach experience low or no flows at certain times of the year, mainly from irrigation withdrawals. The wetted perimeter method was used to calculate a requested flow of 35 cfs or 25,339 acre-feet from January 1 to December 31. Flows are necessary to maintain habitat for the existing trout fishery. The riparian area would also benefit and maintain habitat for several wildlife species. The threatened grizzly bear uses the stream corridor during spring, summer and fall. The endangered bald eagle uses part of the reach during the winter.

McDonald Creek - From the headwaters to the mouth, eight miles. Brook trout are the only game fish present and provide a good fishery. The base flow method was used on this stream to calculate a flow request of 10 cfs or 7,240 acre-feet from January 1 to December 31. A fairly stable flow occurs in this stream. The flow is necessary to maintain the existing trout fishery and the adjacent riparian area. Several wildlife species are dependent on the riparian area, especially the threatened grizzly bear, which uses the area during spring, summer and fall.

South Fork Deep Creek - From the headwaters to the mouth, seven miles. Game fish in the lower portions of the reach include rainbow, brook and cutthroat trout. Flows are generally good throughout the reach. The fixed percentage method was used to request a flow of 6.9 cfs (4,995 acre-feet) from January 1 to December 31. Flows are necessary to maintain habitat for the existing trout fishery. Although fish have not been genetically tested, the potential for pure westslope cutthroat to occur in the upper portions of the reach does exist. For this reason, this stream needs the flow requested. In addition, riparian habitat will be maintained and will benefit wildlife species, including the threatened grizzly bear. This species uses the corridor during spring, summer and fall.

North Fork Deep Creek - From the headwaters to the mouth, eight miles. The fixed percentage method was used to request a flow of 7.2 cfs or 5,212 acre-feet from January 1 to December 31. Flows are generally good throughout the reach. Game fish include rainbow, brook and cutthroat trout in the lower part of the reach. Flows are necessary to maintain habitat for the existing trout fishery. The potential for pure westslope cutthroat exists in the upper portions of the reach; therefore, the requested flows are necessary. The requested flows will also maintain riparian habitat which is important for the threatened grizzly bear during spring,

summer and fall. Several other wildlife species are also dependent upon the riparian area.

Deep Creek - From the headwaters to the mouth, 28 miles. This stream supports a locally important fishery for brook and rainbow trout in the upper reach and rainbow and brown trout in the lower reach of the stream. Cutthroat (of undesignated genetic makeup) are also present in the upper portion of the reach. A requested flow of 18 cfs (13,031 acre-feet) from January 1 to December 31 was determined by the wetted perimeter method. At times, portions of the reach experience low flows from irrigation withdrawals. Flows are necessary to maintain habitat for the existing trout fishery. The flows will also maintain riparian habitat for wildlife species. The threatened grizzly bear uses the stream corridor during spring, summer and fall in the middle and upper portions of the reach.

Spring Creek - From the headwaters to the mouth, 10.5 miles. This stream is very important to the Choteau community, as it flows through the town. Annual plants of catchable rainbow trout are made within the town of Choteau for a kids' fishing area. The city park parallels the stream and many community activities occur throughout the summer. A very good brook trout fishery occurs in the upper portion of the reach. The lower portion of the reach is dewatered in some years from irrigation use. The base flow method was used to determine the flow request. Flows of 4.5 cfs or 3,258 acre-feet from January 1 to December 31 are requested. Flows are necessary to maintain habitat for the existing trout fishery. They would also help maintain the aesthetics within the Choteau community. Flows will help maintain the riparian area which is important for several wildlife species. The threatened grizzly bear uses the upper portions of the reach during spring and fall.

BIOGRAPHY

BILL HILL
OCTOBER 1991

Personal:
Born October 11, 1941, Great Falls, Montana

Education:
B.S. Fish & Wildlife Management, Montana State University, 1963
M.S. Fish & Wildlife Management, Montana State University, 1965

Current Position:
Fishery biologist, MDFWP, Region 4, Choteau, MT

Experience:
July 1969 - Present: Montana Department of Fish, Wildlife & Parks - Fisheries Biologist. Area of responsibility: East of the Continental Divide in North Central Montana, including the Sun River, Teton River and Marias River drainages and a portion of the Dearborn River drainage. Duties include survey and inventory of all lakes and streams and making recommendations to wisely manage the fishery of these waters; working with Montana's stream preservation laws; working with area landowners and sportsmen; and attending public meetings and civic groups to explain the principles of fisheries management.

July 1965 - July 1969: North Dakota Game & Fish Department - Fisheries Biologist. Area of responsibility: Central one-third of the state. Duties involved survey and inventory of lakes and recommending management of these waters. Major emphasis was directed on Lake Sakakawea and Lake Oahe, two large impoundments on the Missouri River.

Special Schools Attended:
1986 - Attended workshop on stream flow measurements and determining stream profiles for the wetted perimeter method. Sponsored by USGS and MDFWP.

1982 - Stream Mechanics and Fisheries course taught at Montana State University.

Publications and Reports:
Hill, William J. 1966. Observations on the life history and movement of goldeye, Hiodon alosoides, in Montana. Proc. MT. Acad. Sci., 26: 45-53.

Hill, William J. 1966-1969. Management surveys of the Missouri River and its mainstem reservoirs in North Dakota. N. Dak. Game and Fish Dept. Progress and Job Completion Reports, F2R13-16. Job No. 1.

Hill, William J. 1968. Surveys of reservoirs, natural lakes and streams for fishery management (statewide). N. Dak. Game & Fish Dept. Progress and Job Completion Report, F2R15. Job No. 4.

Hill, William J. 1968-1969. Fish tagging studies. N. Dak. Game & Fish Dept. Progress and Job Completion Report. F2R15-16. Job No. 9.

Hill, William J., et. al. 1969-73. Inventory of Waters of Project Area. Montana Dept. of Fish, Wildlife and Parks. Job Progress Report. F5R19-23. Job No. I-a

Hill, William J., et. al. 1970-73. Fish Management Surveys. Montana Dept. of Fish, Wildlife and Parks. Job Progress Report. F5R20-23. Job No. I-b.

Hill William J., et. al. 1974-85. Inventory and survey of waters in the Western Half of Region Four. Montana Dept. of Fish, Wildlife and Parks. Job Progress Report. F5R24-35. Job No. I-a.

Hill, William J., 1976. Water Quantity and Quality of the Sun River from Gibson Dam to Vaughn, 1973-74. Montana Dept. of Fish, Wildlife & Parks. Federal Aid Projects. F5R23-24.

Wipperman, Al., S. Leathe and B. Hill. 1986 Inventory and Survey of Salmonids in Lakes and Reservoirs in Region Four. Montana Dept. of Fish, Wildlife and Parks. Job Progress Report. F5R36. Job No. I.

Leathe, Steve A. and W. J. Hill 1986. Inventory and Survey of Cold Water Fish Populations in Rivers and Streams. Montana Dept. of Fish, Wildlife & Parks. Job Progress Report. F5R36. Job No. II.

Hill, Bill and A. Wipperman. 1986. Inventory and Development of Warm/Cool Fish Populations in Region Four Waters. Montana Dept. of Fish, Wildlife & Parks. Job Progress Report. F5R36. Job No. III.

Liknes, George A., W. J. Hill and S. A. Leathe. 1987-90. Survey and Inventory of Coldwater Streams. Montana Dept. of Fish, Wildlife & Parks. Job Progress Report. F46R1-4. Job No. I-G.

Hill, William J., et. Al. 1987-90. Survey and Inventory of Coldwater Lakes. Montana Dept. of Fish, Wildlife & Parks. Job Progress Report. F46R1-4. Job No. IIe.

Hill, William J., et. al. 1987-90. Survey and Inventory of Warmwater Streams. Montana Dept. of Fish, Wildlife & Parks. Job Progress Report. F46R1-4. Job No. III-a.

Hill, William J., et. al. 1987-90. Survey and Inventory of Warmwater Lakes. Montana Dept. of Fish, Wildlife & Parks. Job Progress Report. F46R1-4. Job No. IV-b.

Preliminary Environmental Reviews Prepared:

Hill, William J. 1974. Introduction of cutthroat trout into the South Fork of Birch Creek.

Wipperman, Alfred H., and W.J. Hill. 1979. Black Crappie Introduction - Tiber Reservoir.

Hill, William J. 1980. Yellow Perch, Black Crappie, and Largemouth Bass Introduction - Priest Butte Lane.

Hill, William J. and Kent Gilge. 1984. Spottail Shiner Introduction - Lake Elwell, Lake Frances, Fresno Reservoir, Nelson Reservoir.

Hill, William J. 1985. Yellow Perch, Spottail Shiner and Walleye Introduction in Bynum Reservoir.

Hill, William J. 1986. Spottail Shiner Introduction - Pishkun Reservoir.

Papers Presented:

Great Plains Fishery Workers Association

- Co-Existence of Northern Pike and Kokanee Populations in a North-Central Montana Irrigation Reservoir. Minot, ND. Feb. 1974.
- The Arctic Grayling - 50 Years of Existence in an Irrigation Canal. Regina, Sask. Feb. 1989.
- Predator/Prey Management Problems in Tiber Reservoir, MT. Casper, WY. Feb. 1990.

Montana Chapter American Fisheries Society

- History of Northern Pike in Several North Central Montana Lakes. Great Falls, MT Jan. 1977.
- Expanding the Range of Stream - Dwelling Grayling. Helena, MT Feb. 1984.

517.4

Bill Hill, being first duly sworn, states that the foregoing testimony is true.

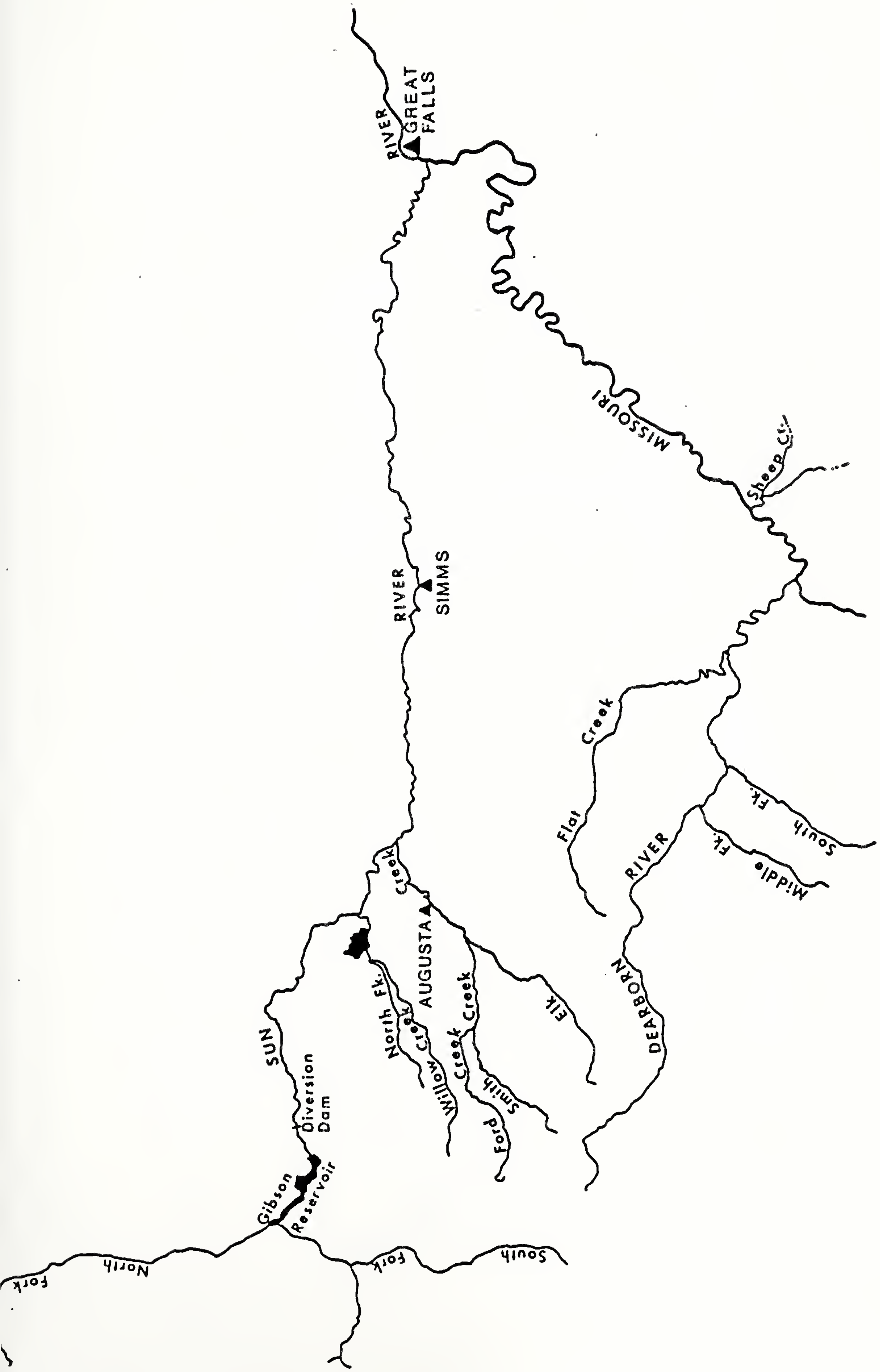
DATED this ____ day of October 1991.

Bill Hill

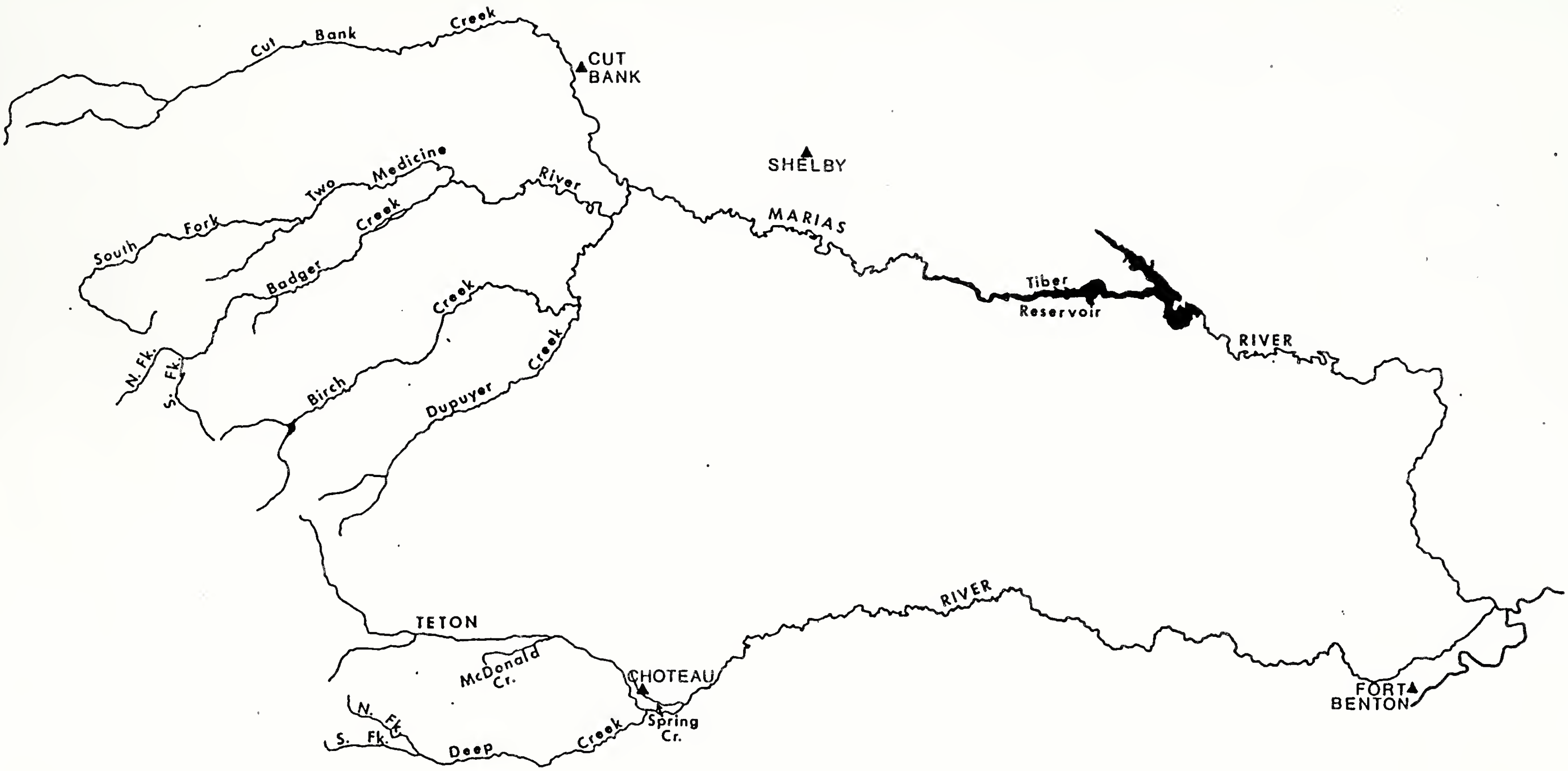
Subscribed and sworn to before me this ____ day of October 1991.

Notary Public for the State of Montana
Residing at Helena, Montana
My Commission Expires________________

Appendix A



Map locating the Dearborn River Drainage and Sheep Creek.



Location map for the Marias River Drainage.

PRE-FILED TESTIMONY OF DANIEL CASEY
ON BEHALF OF THE
MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

Q. By whom are you employed and in what capacity?

A. I am employed by the Montana Department of Fish, Wildlife and Parks as a Wildlife Biologist.

Q. Please state your educational and employment experience.

A. I have worked as a professional biologist for 12 years. I hold both B.S. and M.S. degrees in Wildlife Biology from Colorado State University. My Master's research dealt with the effects of habitat complexity and alteration on breeding bird communities. Following graduation, I worked briefly for the Colorado Division of Wildlife on a big game winter range study. I then spent 3 years as a Wildlife Ecologist with Camp, Dresser and McKee, an environmental consulting firm in Denver. My primary responsibilities included designing and implementing avian baseline studies, and I worked on gamebirds, raptors, waterfowl, songbirds, small mammals and big game and their habitats on projects in Montana, Colorado, Wyoming, Texas and Georgia. During that period I also contributed to a statewide wildlife database for Colorado. For the past 8 years, I have worked as a Wildlife Biologist with the Montana Department of Fish, Wildlife and Parks. My work has all been associated with the identification and mitigation of wildlife and wildlife habitat impacts of hydroelectric projects in northwest Montana. Our work has been funded by the Bonneville Power Administration, under the auspices of the Pacific Northwest Power Planning Act. I prepared the wildlife loss statement for Hungry Horse Dam, which detailed the specific impacts of lost riparian and upland habitats on selected wildlife species along the South Fork Flathead River. For four years, I was the project biologist for a study of the effect of fluctuating water levels (due to dam operation) on the nesting ecology of Canada Geese along the mainstem Flathead River and the north shore of Flathead Lake. I also developed a project to analyze the effects of water level fluctuations on nesting Ospreys and Bald Eagles along the Flathead. I served on the Flathead Working Group, a multi-agency group which developed and reviewed proposals to mitigate the effects of Kerr Dam on fish and wildlife resources in the Flathead system. Currently, I am working on an elk mitigation project at Hungry Horse Reservoir. Details of my experience and a list of publications are included in the attached biography.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to support that portion of the Department's instream flow reservation request that is based on the value of instream flows to the maintenance of riparian habitat quality.

Q. What portion of the Department's application covers material that is supported by your testimony?

A. Volume 1, page 1-45, and those portions of each stream write up in Volumes II and III which discuss the need for instream flows to maintain riparian areas, found under the section(s) "WHY FLOW IS NECESSARY".

Q. What was your involvement in the preparation of the Department's Missouri River Basin water reservation application?

A. I was not involved in the preparation of the water reservation request. I was asked to prepare testimony because of my experience and knowledge of riparian wildlife issues and the relationship between habitat structure and wildlife diversity.

Q. How will the Department's requested water reservations help to maintain the health and vigor of riparian communities in the Missouri River Basin?

A. Riparian communities can be defined as the plants and animals associated with streamcourses and floodplains. Water reservations will help maintain the health and vigor of riparian plant species through the provision of water (either surface or sub-surface) during critical periods in their growth cycle. Surface water is utilized by a wide variety of wildlife species throughout the year for drinking, bathing, or other life requirements. Waterfowl and furbearers, for example, are dependent on stream and riverine habitats for feeding, brood-rearing, travel and denning. From a wildlife standpoint, the habitat diversity provided by riparian vegetation is perhaps the greatest value provided by flowing water. Riparian habitat complexes are an excellent example of the ecological concept of "edge effect" (Johnson 1978), the "tendency for increased variety and density at community junctions" (Odum 1959). For reference to the work of others, I have attached a list of literature cited with complete citations. This list is incorporated as a part of my testimony.

Q. In what ways are the plants found in riparian communities dependent on instream flows such as those requested by the Department?

A. Most of the plant species found exclusively or most commonly in riparian areas are adapted for soils which are saturated

for at least a portion of the year. Some, such as rushes and sedges found in riparian wetlands, are shallow-rooted and therefore dependent on surface or shallow sub-surface water. Other species, such as the cottonwoods which characterize the overstory of much of Montana's riparian forest, are deep-rooted but still rely on the elevated water tables found in riparian soils. Brock (1985) noted that riparian soils are often geomorphically very young and coarse-textured, and therefore transmit water readily and have a low water retention capacity. Therefore, a dependable water supply is essential to assure that riparian soils will serve as growth media for woody vegetation. Harris et al. (1985) collected riparian habitat data along instream flow transects in California and noted that decreased flow can result in decreased riparian cover because of induced soil moisture stress. Odum (1978) noted that flowing water and seasonal (but not catastrophic) flooding increase productivity compared to upland areas. In other arid portions of the western U.S., provision of more consistent flows in intermittent or ephemeral streams has been shown to increase riparian vegetation (Szaro and DeBano 1985). Light to moderate flooding favors establishment and regeneration of riparian communities through deposition of nutrient rich sediment and the moisture necessary for germination (Brady et al. 1985); some species such as willows and cottonwoods are dependent on seasonal flooding for perpetuation of multi-aged stands.

Q. What is the significance of riparian habitats to wildlife, relative to other habitats in the Missouri River Basin?

A. The importance of riparian habitats to wildlife has been well documented in the scientific literature, and their key importance in arid western landscapes is well accepted by the scientific community. Because of their biological importance, and because of documented losses of riparian acreage through conversion to agriculture and other land uses (e.g. Hoar and Erwin 1985), maintenance of riparian habitats is an important wildlife issue across Montana and elsewhere in the west. Indeed, riparian habitat issues have been the focus of several national and regional symposia, three of which I have drawn heavily from in the preparation of this testimony (see literature cited). I attended one of the three, entitled "Lowland river and stream habitat in Colorado: A symposium", held 4-5 October 1978, in Greeley, CO.

Breeding bird communities are frequently used as a "barometer" of habitat richness and health, because they are relatively easy to measure, and respond quickly and dramatically to environmental changes (Johnson 1978). Wooded riparian areas have been shown throughout the west to support higher densities of breeding birds than other (upland) habitats. Beidleman (1978) noted that though riparian areas cover

perhaps 3% of Colorado, they support 40% of the vertebrate species found in that state. Johnson (1978) summarized bird communities in the southwest, and noted that 30-75% of the breeding bird species were either preferential or obligate riparian breeders. Here in Montana, Thompson (1978), Kroodsma (1973) and Walcheck (1970), among others, have documented the diversity of breeding birds dependent on riparian habitats. Walcheck's work in the Missouri River Breaks showed that cottonwood communities supported more than 2-5 times as many breeding pairs and twice the species of birds as did the upland habitats he investigated (specifically, greasewood-sagebrush, sagebrush-grassland, and pine-juniper). Many species groups such as big game which feed in a variety of habitats, including agricultural lands, are dependent on wooded riparian habitat for security and thermal cover during critical times of the year (e.g. fawning, winter).

Q. Which specific wildlife species or species groups are most dependent on riparian habitats, and therefore on instream flows such as those requested by the Department?

A. In my own experience in the Flathead system, there are many wildlife species found almost exclusively in riparian habitats. These include a number of songbird species, waterfowl such as wood ducks, goldeneyes, and mergansers which are found infrequently in other aquatic habitats; ospreys and bald eagles, which nest almost exclusively in mature cottonwood stands; beavers, river otters, and mink. Mature stands of cottonwood, and younger stands of willow/cottonwood on islands were the two most important nesting habitats for Canada geese. Riparian meadows, shrubland, and forest are important security and feeding habitat for white-tailed deer, wild turkeys, and ruffed grouse. In my work in eastern Montana, these same patterns were evident. Riparian shrubland, cottonwood forest and wooded draws are an important component of big game (mule deer, white-tailed deer) and gamebird (ring-necked pheasant, sharp-tailed and sage grouse) habitat, and offer the greatest structural diversity for breeding birds and small mammals in a complex of agricultural and grassland habitats which are generally less diverse. Shallow riparian wetlands are important habitat for dabbling duck species such as the mallard and northern pintail, as well as a variety of migrant and breeding shorebird species. Again, the scientific literature is full of examples where the importance of riparian habitats to specific wildlife species has been quantified.

Q. Were specific wildlife or riparian vegetation considerations incorporated into the calculations of requested flow reservations?

A. No. Quantitative data relative to maintenance of riparian habitat values were not available for specific stream reaches. In fact, I was able to find reference to only a few water rights requests in the west devoted strictly to the maintenance of riparian vegetation (Jonez et al., 1978).

Q. Please explain the relationship between riparian habitat maintenance and the requests made for other purposes.

A. Riparian habitat maintenance is viewed as an important, but secondary benefit of the water reservations requested by the Department. Instream flows in all cases should help maintain existing riparian vegetation, which has corresponding benefits to the wildlife community. Maintenance of existing riparian vegetation can have the additional benefits of dampening the effects of flooding through erosion control, and supplying organic material to the aquatic system, enhancing its productivity (Jahn 1978). Water requests from other entities which would result in seasonal dewatering or impoundment could in many cases result in loss of riparian habitats over time, either through prevention of seasonal flooding essential to regeneration, or through induced moisture stress during the growing season (Harris 1985, Ewel 1978, Johnson 1978).

I, Daniel Casey, being first duly sworn, states that the foregoing testimony is true.

DATED this 24th day of October, 1991.

Daniel Casey
(Name)

Subscribed and sworn to before me this 24th day of October, 1991.

Nadine M Sand
Notary Public for the
State of Montana
Residing at Kalispell
My Commission Expires March 7 1992

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BIOGRAPHY - DANIEL CASEY

October, 1991

PERSONAL:

Born 16 September 1955, Charlottesville, Virginia.
Social Security Number: 144-52-5596

EDUCATION:

B.S. Wildlife Biology, Colorado State University, Dec. 1976
M.S. Wildlife Biology, Colorado State University, Apr. 1979

EXPERIENCE:

1987 - Present: Montana Department of Fish, Wildlife and Parks. Project biologist for Hungry Horse Elk Habitat Enhancement Project. Responsibilities include the development of habitat enhancement prescriptions, design and implementation of habitat and population monitoring. During this period I also served as our agency's representative to the Flathead Working Group. This multi-agency group developed and analyzed various options for mitigating the effects of water level fluctuations due to the operation of Kerr Dam. These included flow options designed to enhance or protect riparian habitat values, fish populations and/or wildlife populations along Flathead River. Examples included timing, peak, and minimum flow restrictions designed to protect nesting geese, river otters, ospreys, bald eagles, and muskrats.

1984 - 1987: Montana Department of Fish, Wildlife and Parks. Wildlife Biologist responsible for study of water level effects on the nesting ecology of Canada Geese. Determined number and distribution of nesting pairs, and monitored nest success as related to water levels and other factors. Determined river flow levels at which island ground nests were susceptible to flooding; also those flow levels which dewatered channels which otherwise offered protection from predators. This project also included an analysis of habitat selection on nesting islands, and the role which water level fluctuations played in habitat structure and distribution. Studied goose brood use relative to habitat quality in the zone of water level fluctuation. Developed study plan, collected data, and coordinated efforts with other simultaneous studies of riparian habitat dependent species (osprey, bald eagle, furbearers).

1983 - 1984: Montana Department of Fish, Wildlife and Parks. Wildlife Biologist responsible for the determination of wildlife habitats and species lost when Hungry Horse Dam was built on the South Fork Flathead River (1954). Through review of aerial photos, historic survey data, and known habitat

affinities of selected wildlife species, calculated specific loss statements for riparian and upland habitats in the reservoir pool area. Most of the species considered were highly dependent on riparian communities.

1980 - 1983: Camp, Dresser and McKee, Inc., Denver, Colorado. Wildlife Ecologist in charge of design and implementation of avifauna studies for environmental consulting firm. Projects included large-scale baseline studies for mining and land-exchange projects in Montana, Wyoming, Colorado, Texas, and Georgia. Through field studies and literature review, described wildlife communities and habitat affinities in project areas. Worked with breeding bird communities, gamebirds, waterfowl, birds of prey, small mammals and big game. Specific projects included a coal gasification siting study near Glendive, a land exchange near Circle, and a hard rock mine in the Stillwater River Valley. During this period I also contracted with the Colorado Division of Wildlife to provide detailed distribution, life history and habitat requirement data for all species of waterfowl and vireos which occurred in the state, for a statewide wildlife database.

1979 - 1980: Colorado Division of Wildlife. Wildlife Technician. Collected data on important big game winter ranges to attempt to quantify carrying capacity. This involved use of an electronic capacitance meter to estimate forage biomass, with corresponding direct measurement (clipping and weighing) to construct and validate a model predicting total forage volume.

1977 - 1979: Colorado State University. Graduate Research Assistant. Master's research in Pennsylvania on the effect of browsing by deer and elk on forest habitat and the corresponding breeding bird communities. This included detailed literature review on the relationship between habitat structure and bird species diversity. Much of this type of research has been done in riparian forests and other deciduous forest types. Field data collection included breeding bird surveys, measurement of foliage density and other forest structure variables.

1973 - 1979: Colorado State University. Undergraduate Work Study. Assisted professor in the Fishery and Wildlife Department with waterfowl trapping, bird surveys in riparian greenbelt, wetland, and shortgrass prairie sites. Also extensive lab and library work.

PUBLICATIONS AND REPORTS:

Butler, D. Casey. 1979. The effects of a high-density population of ungulates on breeding bird communities in deciduous forest. M. S. Thesis, Colorado State Univ., Fort Collins. 67p.

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plan, elk and mule deer winter range enhancement, Firefighter Mountain and Spotted Bear winter ranges. Prep. by Montana Dept. Fish, Wildlife and Parks for Bonneville Power Admin., Portland, OR. 89p.

Casey, D., and P.R. Malta. 1990. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Interim (annual) Report. Montana Dept. Fish, Wildlife and Parks, Kalispell. 85p.

Casey, D., and P.R. Malta. 1990. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Monitoring and evaluation plan. Montana Dept. Fish, Wildlife and Parks, Kalispell. 56p.

Casey, D., and P.R. Malta. 1991. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Annual Rept.- FY91. Montana Dept. Fish, Wildlife and Parks, Kalispell. 41p.

I also have prepared numerous monthly, quarterly and annual reports for our mitigation work in the Flathead, and wildlife sections for detailed environmental documents as a consultant. I was the sole author of the following:

Beak Consultants, Inc. 1983. Literature review for the Circle wildlife studies, McCone County, Montana. Final Report, Vol. II. for: Meridian Land and Mineral Co., Billings. 44p.

Camp, Dresser, and McKee, Inc. 1983. Clinical case study of high-walls for wildlife use. Literature Review for: Western Energy and Land Use Team, USFWS, Fort Collins, CO. 32p.

OTHER QUALIFICATIONS:

Certified Wildlife Biologist, The Wildlife Society, 1988.
Member, Montana Bird Distribution Verification Committee.
Member: American Ornithologists' Union
Wilson Ornithological Society
Society of Field Ornithologists
Prepared testimony for FERC relicensing of Kerr Dam, 1984.

Pre-filed Direct Testimony
# of Ken Knudson
on behalf of the
Montana Department of Fish, Wildlife and Parks (DFWP)

Q. Please state your name and business address.

A. Ken Knudson
Ecological Resource Consulting
540 Breckenridge
Helena, MT 59601

Q. What is your occupation?

A. I am a self-employed biological consultant and owner of the above Helena-based firm.

Q. Please state your educational background.

A. I was educated within the Montana public school system. I graduated from Thompson Falls High School (valedictorian) in 1965. In 1969 I received a BA in zoology and in 1972 a MS in aquatic biology from the University of Montana.

Q. Please state your employment experience.

A. I have worked as a professional biologist for 19 years. From 1972-74 I was employed as an environmental biologist for the Texas Parks and Wildlife Department, where I participated in joint state/federal efforts to improve water quality and quantity conditions in the Galveston Bay area. From 1975-81 I was the pollution control biologist for the Montana Department of Fish, Wildlife and Parks. Among other duties, I helped prepare the Department's Yellowstone River instream water reservation application and was a witness during the contested case hearing. While with DFWP I also conducted some of the first investigations defining the minimum streamflows necessary to sustain the trout fishery of the upper Clark Fork River. I was the project biologist for the Governor's Clark Fork River Basin Project from 1985-86. I helped coordinate over 30 state, federal and university studies that evaluated water quality, quantity, fish habitat and land use activities in the basin, including the instream flow reservation studies conducted by Fish, Wildlife and Parks and the Montana Department of Natural Resources and Conservation.

From 1982-84 and 1987 to the present, I have been a biological consultant. Most of my contract work has involved the review, analysis and discussion of water resource data. I have prepared or critiqued Environmental Analyses, Environmental Impact Statements and other documents mandated by the Montana

Environmental Policy Act or other legislative directives. I have also written other reports or articles, translating technical data into a form understandable by non-scientists. My clients include state, federal and local government agencies, private landowners, homeowners' associations and public interest groups. These persons have used and relied upon my analyses, reports and opinions in making water resource decisions. I was a full-time lobbyist during the 1983 Montana legislative session. My diverse employment experience gives me a broad perspective on the development and intent of the water reservation process in Montana. Further details of my experience and publications are included in the attached biography.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to support the Department's position that its Missouri River instream flow reservation is in the public interest.

Q. What was your involvement in preparation of the Department's Missouri River water reservation application?

A. I outlined the approach taken by the Department to address the Public Interest section of the application, following the requirements under ARM 36.16.105C. I analyzed the direct and indirect benefits and costs of the reservation; the non-economic benefits of the reservation to the environment, public health, welfare and safety, and to other users or parties; the effects of not granting the reservation; and alternative actions that could possibly be taken if the reservation is not granted. I also combined my report of this information with a report by Dr. Joe Elliot (dated January 1989) into a draft document for the Public Interest section of the Department's application. This April 1989 report, which also includes my analysis and discussion of the non-quantifiable benefits of the Department's reservation request, is included as Exhibit 6 in the Department's exhibits filed with this testimony.

Q. Describe the work that you did to arrive at the conclusions reached in your testimony.

A. I reviewed and analyzed studies, reports and articles prepared by federal, state and local agencies, universities and private individuals. These documents are listed in the literature cited section of Exhibit 6. If I had questions or needed additional information, I contacted the document(s) author(s). My testimony is essentially a summarized analysis of the findings and conclusions of these reports and conversations.

Q. What are the direct benefits of the Department's Missouri

River instream flow reservation?

A. Direct public benefits of the Department's reservation request include preservation of the fisheries resource, resulting in continuation of the basin's exemplary sport fishing values. Benefits also include protection of the basin's extensive and diverse recreational floating opportunities and maintenance of existing riparian communities.

The national significance of Montana trout streams was brought clearly into focus in the spring 1989 issue of Trout--The Magazine for Trout and Salmon Anglers. The feature article of this issue, a special publication commemorating the thirtieth anniversary of the magazine, was "America's 100 Best Trout Streams". Of these 100 nationally-acclaimed fishing streams, 12 are in Montana, which has the highest total of any state in the nation. Alaska ranks second to Montana with 11 listed streams followed by Idaho (9), New York (6) and Wyoming (6). It is significant to note that 6 of America's best 100 trout streams, (i.e., the Beaverhead, Big Hole, Gallatin, Madison, Missouri and Smith rivers) are in the portion of the Missouri Basin covered by the DFWP's instream reservation.

The fisheries resource that would be protected by the Department's reservation is exceptional. The rivers and streams of the Missouri above Canyon Ferry Reservoir accounted for 375,239 of the total 1,193,000 days spent stream fishing in Montana during 1985. Despite being less than 10% of the geographic area of Montana, the upper Missouri supported 31.4% of the state's stream fishing.

The fact that hundreds of thousands of people annually fish the upper Missouri Basin is testimony to the wild (naturally reproducing) trout fishery that is found there. Very high angler success rates for wild brown and rainbow trout have made the Madison one of the most popular rivers in North America. Some reaches of the Madison contain over 3,500 catchable trout per mile. The salmonfly hatches of the Madison, Big Hole and Gallatin rivers are legendary, attracting a following of anglers who annually chase "the hatch" from river to river. Due to its relatively undeveloped watershed, the Big Hole River is one of the largest trout streams outside designated national wilderness areas that remains essentially non-turbid during runoff. This river is also the home of the last remaining population of stream-dwelling Arctic grayling in the lower 48 states. The Gallatin River is another nationally-acclaimed trout stream, offering a wide variety of fishing experiences--from swift-gradient, mountain canyons to slow-moving, broad valley sections.

Portions of the Madison, Big Hole, Gallatin, Beaverhead and Missouri rivers are exceptional fishing streams on a national

scale and are rated by DFWP as Class One, "blue ribbon" trout streams. This distinction has been given to only a select number of streams in Montana that are considered to have "the highest valued fishery resource" in the state. The Ruby, East Gallatin, Jefferson and Red Rock rivers are also very important trout streams, as are many tributaries of the basin's major rivers. The tributaries not only serve as vital spawning streams for the larger rivers, but also often contain an abundance of resident trout. These smaller trout streams provide heavily utilized backcountry stream fishing opportunities. For example, the Big Hole River tributaries received 18,624 days of angler use in 1985 and support fisheries for rainbow, brook and cutthroat and arctic grayling.

During 1985, the Missouri River from Holter Dam to the town of Cascade sustained over 6% of all stream fishing pressure in Montana (72,788 angler-days). Since this high amount of usage occurred along only 35 miles of river, this reach of the Missouri received more recreational fishing per mile than any other stream in Montana. The Madison River, for example, also received heavy use (108,712 angler-days, the highest total use of any Montana stream), but it was dispersed along more than 80 miles of river.

The Missouri River above Canyon Ferry Reservoir not only contains resident populations of rainbow and brown trout, it also supports spawning migrations of trout from the reservoir. The significant amount of fishing that occurs for these migrants is the primary reason for the "blue ribbon" rating of the river between Toston Dam and Canyon Ferry Reservoir. The 3.5-mile stretch of free-flowing river between Hauser Dam and Holter Reservoir is a very important fishery for migrant trout and Kokanee salmon.

Fish migrations from reservoirs and lakes throughout the basin provide many important stream fishing opportunities. Many tributaries to reservoirs or lakes that contain a trout fishery support spawning runs when adequate habitat, water quality and instream flows exist in these feeder streams. In addition to the fishing they provide, these spawning runs also sustain the trout populations of many reservoirs and lakes.

The benefits of adequate instream flows, therefore, extend beyond flowing waters to include preserving fishing opportunities in reservoirs and lakes. These water bodies support a significant amount of recreational fishing. In 1985, reservoirs and lakes in the Missouri Basin above Holter Dam supported 322,661 angler-days; in the basin below Holter Dam to Fort Peck Reservoir, these water bodies supported 160,704 angler-days. Combining these figures demonstrates that the portion of the Missouri Basin covered by the

reservation request supported 483,365 days of reservoir and lake fishing, which was 44.7% of the statewide total.

Many streams in the Missouri Basin contain locally important trout populations. For example, the upper Judith, Smith and Musselshell rivers, Big Spring Creek near Lewistown, and the 20-mile reach of the Marias River below Tiber Dam, provide quality trout fishing for residents of Lewistown, Harlowton, Chester and other nearby communities. For its size, Big Spring Creek is an exceptional rainbow and brown trout fishery, with population estimates approaching 3,000 catchable trout per mile. The Smith River, which enters the Missouri just above Great Falls, is also an important trout stream. Although relatively small and inaccessible, it sustained 11,824 fishing days in 1985. Without adequate instream flow protection for these and other tributaries of the middle Missouri, many residents of northcentral Montana would have to travel several hours to find similar stream fishing.

From Morony Dam below Great Falls to Fort Peck Reservoir, the Missouri River and its tributaries support a warmwater fishery of national, if not international, significance. Although it presently receives a relatively small amount of angler use, this 207-mile, free-flowing reach contains an exceptionally diverse, unique and presently under-utilized fishery.

According to DFWP studies, of the 18 families and 80 species of fish reported to occur in Montana, 14 families and 53 species are found in this reach and/or its tributaries. Of Montana's 52 native fish species, 35 are found in the middle Missouri Basin below Great Falls.

The paddlefish population of the middle Missouri/Fort Peck Reservoir system is of particular importance. Paddlefish are Montana's largest gamefish, with female specimens often reaching 5 to 6 feet in length and weighing 75 to 125 pounds. Once abundant during the Triassic Period 150 million years ago, these primitive fish are presently found in only two river basins--the Yangtze in China and the Mississippi/Missouri. Although "spoonbill cats" once supported a significant commercial fishery, particularly along the Mississippi, stream channelization, dams, over-harvesting and alteration of streamflows have reduced the range of paddlefish in the United States to only six isolated, self-sustaining Mississippi/Missouri populations.

Growth rates in the middle Missouri/Fort Peck paddlefish population are superior to the other five remaining populations. The middle Missouri population is also older (in terms of average age of fish) and more secure than anywhere else in North America. This security and biological success is largely due to the unaltered, free-flowing characteristics

of this reach of river, which provides essential and irreplaceable spawning areas for paddlefish.

The relatively undeveloped characteristics of the middle Missouri also provide the most secure unaltered habitat remaining in the Mississippi/Missouri Basin for two other relics of the dinosaur era--the pallid and shovelnose sturgeons. Sitings of the pallid sturgeon have not been common during the past few decades. Only one pallid sturgeon was captured in the middle Missouri during electrofishing studies conducted by DFWP between 1975-80. During more extensive surveys by the Department from 1981-1991, a few more of these fish were found. However, this species is very rare both in Montana and the rest of the nation. Because of this dangerously low population level, the U.S. Fish and Wildlife Service (USFWS) has listed pallid sturgeon as an endangered species.

The shovelnose sturgeon population of the middle Missouri River is healthy and vigorous. Shovelnose residing in the Missouri above Fort Peck Reservoir are much larger than those found in the Missouri River in South Dakota, the Mississippi River in Iowa and the Chippewa River in Wisconsin. In fact, the average size of shovelnose from the middle Missouri equalled or exceeded the maximum size of those from the South Dakota, Iowa and Wisconsin rivers.

Significant sport populations of sauger and channel catfish are also found in the middle Missouri. Growth of channel catfish in this river reach is equivalent or superior to growth in other northern waters and compares favorably with the growth of this species in lakes and rivers of southern states. Channel catfish, sauger and shovelnose sturgeon all utilize the free-flowing middle Missouri, as well as lower reaches of the Marias and Judith rivers, for spawning. The middle Missouri also supports spawning runs of goldeye, bigmouth buffalo and smallmouth buffalo, which contribute to the commercial fishery in Fort Peck Reservoir.

Based upon return rates by anglers of fish tagged by DFWP, the middle Missouri is an under-utilized fishery resource. Opportunities for steady growth in the recreational use of the middle Missouri are, therefore, very good. Protection of adequate instream flows would allow this potential to materialize as well as help assure the continued existence of this unique and valuable fishery resource.

Preserving instream flows will directly benefit recreational floating by helping to maintain existing water depth and velocities on those streams large enough to accommodate canoes, rafts and other types of floating craft. Flows which are sufficient to enable these craft to operate will benefit

recreational floaters as well as fishermen who float to fish these rivers.

The Missouri River and its tributaries are extensively used and popular for floating. Nearly half of the pages of "The Floater's Guide to Montana" are devoted to float trips in the Missouri Basin. From the spectacular canyons of the Dearborn, Smith and Gallatin rivers to the meandering solitude of the Marias, Red Rock and middle Missouri rivers, the basin abounds with floating opportunities.

Of particular importance is the Missouri River from Fort Benton to Fort Peck Reservoir, the largest free-flowing and relatively unaltered, uninhabited segment of the nation's longest river. Congress, in recognition of the extraordinary biological, recreational, scenic and historical values found along these 149 miles of river, officially designated this reach as a National Wild and Scenic River in 1976. Although this designation allows minor withdrawals of water for agricultural purposes, no dams are allowed and specific protection measures must be taken before any large-scale human development can occur. For 149 miles the river winds through spectacular breaks, cliffs and badlands within a gorge several hundred feet below the Great Plains. There are no channel pilings, flood walls, rock and concrete flow deflectors, dams, reservoirs or large irrigation structures that typify the "Mighty Mo" as it sluggishly travels from Fort Peck to its confluence with the Mississippi River. Only from Fort Benton to Fort Peck does the Missouri remain as it existed for prairie-dwelling Native Americans, Lewis and Clark, and the steamboats that were the vanguard of the first major immigration of people into Montana during the last century.

The reservation would also provide benefits beyond those that can be reasonably quantified in economic terms. Adequate streamflows would help enhance the visual attributes of river bottom lands by keeping riparian plant communities healthy and viable, and by providing habitat for wildlife and birds that visitors and residents enjoy observing. The attractiveness of a stream is also closely tied to its water level. Instream flows below those requested by the Department would lead to increases in exposed (dewatered) channel reaches as well as decreases in total living space available for fish and other aquatic life. The reservation would help preserve both the volume and surface area of streams, thereby perpetuating sport fishing and, where presently conducted, river floating opportunities. These amenities are substantial and irreplaceable social, aesthetic and recreational benefits of the reservation to citizens of the Missouri basin. The opportunity to fish, float or swim in the streams, observe wildlife and birds, or to simply enjoy the serenity of sparkling waters beneath the shade of cottonwoods in riverside

parks, contribute immeasurably to the quality of life in basin communities. The biological abundance and diversity found along rivers and within riparian areas also attract increasing numbers and kinds of persons who recreate along streams, i.e., photographers, bird-watchers, science students, hunters, berry-pickers and naturalists.

From its blue ribbon headwaters to its wild and scenic lower reaches, the Missouri River and its tributaries are enormous recreational and aesthetic assets to the people of Montana and the nation. In order to protect these resources and provide future opportunities to enhance these public benefits, it is essential that the instream flows requested by the Department be granted.

Q. What are the indirect benefits of the Department's Missouri River instream flow reservation?

A. Indirect benefits are those benefits of the DFWP reservation that accrue to municipal, industrial and agricultural uses or parties.

Q. What are the indirect benefits of the Department's reservation to municipalities?

A. Municipalities would benefit from the DFWP reservation because of increased assurances about the future physical availability of drinking water. Maintenance of instream flow levels would help sustain water levels at city intake structures and infiltration galleries. If incremental streamflow depletions were to continue as they have occurred in the past, relocation of these supply structures and/or development of alternative water supplies could be necessary. Either of these alternatives would be costly for municipalities.

Q. What are the indirect benefits of the Department's reservation to industry and businesses?

A. Hydropower is a major beneficiary of instream flows. According to the DNRC, nine hydroelectric facilities in the Montana portion of the Missouri Basin, including four near Great Falls, along with Holter, Hauser, Ennis, Canyon Ferry and Fort Peck dams, annually produce about 3.7 million megawatt hours of electricity. Nearly half of this electrical energy is produced at Canyon Ferry and Fort Peck dams.

The indirect economic benefits of instream flows to the nine hydroelectric facilities in the Montana portion of the basin are significant. When the price of electricity, as quoted by the Western Area Power Administration in 1987, is applied to the electrical production rates at these Montana facilities, the value of wholesale power produced ranges from $27,800,000

to $51,800,000 per year (i.e., 3.7 million megawatts per year x 7.5 to 14 mils per kilowatt-hour). These estimated values are conservative; roughly one-half of the hydroelectric power production in the Missouri Basin in Montana is from private facilities, which typically receive a much higher sale price for their electricity.

The instream flows requested in this application and those required for existing hydropower facilities are therefore mutually supportive as long as water release schedules from these dams are closely tied to the needs of fish and water-based recreation. The reservation would help maintain the electrical generating capacity of the hydropower plants on the Missouri River, which currently provides some of the most economical electrical power in the United States.

Tourism-related businesses constitute an important and expanding industry in Montana. The Department's instream flow reservation would help protect the outstanding scenic and recreational values of the Missouri's free-flowing waters that help attract tourists to our state. Labor statistics analyzed by the University of Montana in 1987 revealed that growth in tourism-related services sector jobs is very significant. During the first half of the 1980s when the wood products, metal mining, energy development and agricultural industries were stable or declining, the services sector of Montana's economy steadily generated 18,000 new jobs.

River-based outfitting businesses also benefit from the maintenance of adequate instream flows. The percentage of statewide fishing and outfitting businesses that are located in the upper Missouri Basin closely approximates the angler-use data discussed earlier. About 31% (83 out of 270) of the licensed fishing outfitters and guides who requested to be listed in the Department of Commerce's 1988 Montana Travel Planner were headquartered in cities and towns of the upper Missouri Basin.

In 1986, according to DFWP, a statewide total of 205 registered Montana fishing outfitters provided 10,213 clients with 20,128 fishing days. In that year, 187 outfitters also listed the major rivers that they have worked. A total of 104 of those outfitters (56%) worked rivers and streams in the Missouri Basin.

Along with outfitting, the economic success of many other services sector businesses, ranging from motels, campgrounds and restaurants, to sporting goods stores, automobile service stations and gift shops are dependent upon income from non-resident visitors.

The DFWP reservation would not only protect opportunities for

the perpetuation and enhancement of recreational and service sector businesses, but the amenities it would help maintain would also help attract new kinds of businesses which offer employment opportunities beyond those traditionally credited to recreation. Specialty food and mail order companies, computer and data processing businesses, and consulting firms are examples of "distance-independent businesses", since they typically do not consider distance from markets a liability and, therefore, are often successful in "remote" areas like Montana.

Areas of the state that are endowed with an abundance of spectacular trout rivers like the upper Missouri River Basin, have the highest potential for attracting both tourists and distance-independent companies. Significant new growth in the latter is evident in the upper basin. During the 1980s several small- to mid-sized companies moved to Bozeman. According to the Gallatin Development Corporation (GDC), recreational opportunities and local trout streams are major selling points for attracting new businesses to the Bozeman area. The GDC promotional video "Pioneering for the Future", mentions fly fishing several times and all of the newly-arrived distance-independent companies have at some time commented on the recreational opportunities available in the area.

For example, a spokesperson for Patagonia, an outdoor clothing manufacturer, stated that Bozeman was chosen by the company "primarily because of the recreational opportunities not available in Ventura" (the former California site of the business). She further stated, "Ventura is a great town, but there are not a lot of great rivers. You can't fly-fish there either. Bozeman has all those things and you can get to them relatively easily."

The recreational and aesthetic attributes of rivers and streams that attract tourists are also responsible for attracting new, economically independent residents to Montana. An increasing number of retired persons and/or persons endowed with sufficient interest, dividend or rent incomes, are choosing to move to areas with uncrowded, high-quality recreational opportunities and aesthetically pleasing natural settings. Many of these persons, especially those seeking fishing, floating and scenic values, are moving to the Missouri Basin in Montana. According to University of Montana studies, the contribution to Montana's economy made by these independent, "non-labor" income sources is substantial; it presently accounts for over one-third of Montana's economic base. In recent years, non-labor income has added nearly 4 billion dollars per year to the state's economy, compared to Montana's total labor income of about 7 billion dollars per year.

Q. What are the indirect benefits of the Department's reservation to agriculture?

A. Regardless of the amount of water apportioned for instream flow reservations, existing water rights in the basin would at all times be honored. If the DFWP's reservations are granted, existing water users would be provided with additional assurances of future surface and groundwater availability. Reserved instream flows would help maintain water levels at existing headgates and would provide a legal buffer to any future water development plans by new water users. During low flow years, maintenance of existing streamflows could also help ease conflicts between junior and senior water users in the basin.

Instream flows often recharge shallow, alluvial groundwater tables that adjoin rivers and streams. Maintenance of these vital groundwater systems provides additional benefits to agriculture.

The riparian vegetation that is supported by shallow groundwater, e.g., willows, cottonwoods, birch and aspen, all have extensive root systems that stabilize streambanks and channels. The soil stability provided by healthy, well-managed riparian areas not only prevents erosion, but good riparian areas also reduce the potential for flood damage to croplands and farm buildings. In many valleys of the upper basin, moist meadows and other riparian-like areas are often used to grow alfalfa and hay crops, or as highly productive pasture lands. Many of these sites are "sub-irrigated" by shallow water tables that are recharged by surface water. The DFWP reservation would help maintain these moist growing sites. New diversions could reduce essential recharge which could lower the productivity of these existing agricultural lands.

Finally, streamside aquifers are often utilized for domestic, livestock or irrigation water supplies. The reservation could help sustain existing water table levels, and thereby, the availability and/or quantity of these shallow groundwater supplies.

Q. Are there other indirect benefits of the Department's reservation, including those that can not be reasonably quantified?

A. Yes. Protection of the basin's natural environment through adequate instream flows does far more than just preserve hydrologic conditions and biological abundance. It also benefits the human environment as well as the public's health and safety.

The combination of exercise and relaxation that is part of fishing, floating and other water-based recreation benefits physical health, while providing welcome relief from the mental stresses of everyday life. The sociological benefits of river recreation are also important. River outings provide opportunities for families and friends to socialize or meet new people in a relaxed and aesthetically pleasing setting. Sharing these pleasant experiences benefits and expands interpersonal relationships.

Many people float rivers only to fish, but others enjoy the cultural and historical aspects associated with flowing streams throughout the Missouri Basin. Retracing the journeys of early explorers like Lewis and Clark, Mullan, Colter, Bozeman and others requires adequate instream flows for present-day river navigators. Yet, just as importantly, these streamflows also help preserve the natural setting or viewing backdrop of river bottoms, at numerous recreational sites in the basin, including the Big Hole Battlefield National Monument, Headwaters State Park and the Wild and Scenic stretch of the Missouri River.

The rivers and streams of the Missouri Basin, therefore, not only provide ongoing recreational and health benefits, they are also vital and important linkages to our past. These flowing waters and the riparian vegetation that they nourish are as much a part of the historical, social and cultural environment of the basin as are any human-fabricated structures or devices. The DFWP instream flow reservations would, therefore, help protect irreplaceable components of the Missouri Basin's human environment.

Adequate instream flows are also important for the convenience and safety of floaters. Hazards, such as large boulders, logs, gravel bars, rip rap and diversion structures, can often be avoided by floaters if streamflows are high enough to allow maneuvering. The requested flows would contribute to maintenance of water levels sufficient to reduce such inconveniences and safety hazards on floatable streams.

Q. Are there any direct costs associated with the Department's reservation?

A. The direct costs associated with the DFWP reservation would be monitoring streamflows on certain stream reaches. The Department may have to install or relocate some gauging stations and may have some in-house costs to implement whatever program is needed to protect the granted reservations.

Q. Are there any direct or indirect costs of the Department's reservation to municipalities?

A. The Department's reservation request would not have an impact upon water availability for basin communities if municipal requests are granted first priority during the reservation proceedings, or if future municipal growth is supplied by groundwater. The latter may become more attractive to communities in the future because of water quality concerns; e.g. elevated arsenic concentrations in the Madison and Missouri rivers. Concerns about the increased presence of Giardia cysts and other water-borne disease agents in the basin's surface waters may also lead to increased utilization of groundwater for public drinking water supplies.

Q. Are there any direct or indirect costs of the Department's reservation to industry?

A. The DFWP reservation would have no impact upon existing or new industrial consumption of groundwater, but it could affect future use of surface water by industries. However, no applications have been made for consumptive use of water by industries in the portion of the Missouri basin covered by the Department's reservation request. The DNRC report "Montana Water Use in 1980" states that self-supplied industrial water use in this portion of the basin amounts to less than 0.003 million acre-feet per year.

According to the Northern Lights Institute, the largest industrial consumptive use of water in the ten-state Missouri River Basin is for thermoelectric power generation, but even this usage is relatively minor. For example, water withdrawals for the seven coal-fired electric plants in the Yellowstone Basin amounted to 0.094 million acre-feet in 1980, but only about 10% of this water was actually consumed. There are no thermoelectric power plants in the portion of the Missouri River basin covered by the Department's reservation request. Water for power plants or other industrial development could be supplied by groundwater, water stored during runoff and/or by lease or purchase of existing water rights.

Q. Are there any direct or indirect costs of the Department's reservation to agriculture?

A. Instream water reservations would not affect existing agricultural use in the basin, nor would they necessarily preclude the use of groundwater or water stored in offstream reservoirs for the development of additional irrigation. Reservations could limit future expansion of irrigated agriculture if new surface water sources are needed. However, the potential cost of the DFWP reservation to newly irrigated crop acreage in the Missouri Basin would be relatively minor.

The most current data regarding present and potential

irrigated acres within the Missouri River Basin in Montana can be found in the DNRC's June 1991 Environmental Impact Statement for water reservation applications. According to page 41 of this document, there are presently 1,244,000 acres of irrigated land in the basin above Fort Peck Dam. The EIS (Page 134) states that 133,294 newly irrigated acres are marginally feasible for development; i.e., have at least a 50% chance of being economically viable. This equates to an increase of only 10.7% in irrigated acres. Furthermore, this potential cost of the DFWP's reservation is likely overstated since some of these irrigation needs are planned to be or could be supplied by groundwater. Many of the least economically viable projects are unlikely to ever be financed.

Q. Will the expected benefits of the Department's reservation exceed the costs?

A. Yes. The direct and indirect benefits of the reservation are substantial, covering a broad spectrum of the public interest. The potential costs of the Department's reservation are relatively minor and would not cause any irretrievable losses to other uses or parties.

Further cost/benefit analysis can be found in the DNRC's Missouri River Water Reservation EIS on page 254. Here, the costs and benefits of three possible alternative levels of irrigated acreage are compared--a "consumptive alternative", providing irrigation to 212,209 new acres; a "combination alternative", irrigating 133,294 new acres; and an "instream alternative", that would provide 46,950 acres of newly irrigated land (see pages 133 and 134). All of these alternatives have greater net costs than benefits (Table 7-2).

On the other hand, a true instream alternative, one that would not divert any water for consumptive uses like irrigation would not incur any of the costs associated with the three new irrigation alternatives; i.e., there would be no reduced recreational benefits, no losses to hydropower production or any costs for replacing electrical power (see Table 7-1, page 253). In essence, an instream flow reservation as proposed by the Department, if included in Table 7-1, would be more favorable than any of the alternatives for expanded irrigation.

Q. Will the net benefits associated with granting the Department's reservation likely exceed the net benefits of not granting the reservation?

A. Yes. As described earlier in my testimony, granting the Department's reservation would benefit many diverse uses and parties. Not granting the reservation would not significantly

benefit any of these uses, but rather, could result in substantial costs if streamflows in the basin continue to be incrementally depleted.

Q. Did you examine alternative actions available to the Department if their reservation is not granted?

A. Yes. I examined several possible courses of action, including intensification of water conservation and management practices, buying or leasing water rights, constructing offstream water storage facilities, revising the process for conditioning water right permits, closing basins (rejecting additional water use permit applications) and application of the public trust doctrine.

Q. Do any of these alternative actions have greater net benefits than granting the Department's reservation request?

A. No. All of the alternatives examined were either more costly, limited in applicability, legally untested or logistically unfeasible for basin-wide utilization. Some of these alternatives may be worthwhile as supplements to protection of instream flows through water reservations, particularly on a site-specific basis. Water conservation practices could help increase instream flows if the conserved water is not simply diverted by other offstream users. Stored water could augment instream flows if the stream below the dam is not a losing stream; i.e., losing more surface water to aquifers than it receives from groundwater recharge during summer, low-flow conditions. The law requiring that new water use applications be "conditioned"; i.e., that certain public interest and reasonable use criteria be demonstrated before a permit is granted, only applies to applicants requesting more than 4000 acre-feet of water per year. The public or DFWP can not request that a basin be closed to additional water right applicants; this procedure can only be initiated by existing water users within a given basin. Water leasing in Montana is in its infancy, with an unknown future. Consequently, the reservation process is the best proven procedure for systematically addressing the public's interest regarding instream and future consumptive water needs in an entire basin.

Ken Knudson, being first duly sworn, states that the foregoing testimony is true.

Dated October 31, 1991.

Ken Knudson

Ken Knudson

Subscribed and sworn to before me this 31st day of October, 1991.

Debra McRae

Notary Public for the State of Montana
Residing at Helena, Montana
My Commission Expires May 14, 1994

BIOGRAPHY

KEN KNUDSON
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EDUCATION:

May 1965	High School Diploma (Valedictorian), Thompson Falls, Montana
June 1969	B.A. Zoology, University of Montana, Missoula, MT
June 1972	M.S. Aquatic Biology, University of Montana, Missoula, MT

CHRONOLOGY OF PROFESSIONAL EXPERIENCE:

6/86 - Present:	**Consulting Biologist** Private Practice Helena, Montana
2/85-5/86:	**Project Biologist** Clark Fork River Basin Project Governor's Office Helena, Montana
10/81-1/85:	**Consulting Biologist** Private Practice Helena, Montana
11/74-9/81:	**Pollution Control Biologist** Montana Department of Fish, Wildlife and Parks Helena, Montana
3/72-10/74:	**Environmental Chemist** Texas Parks and Wildlife Department Seabrook Marine Laboratory Seabrook, Texas
3/70-6/71:	**Teaching Assistant** Department of Zoology University of Montana Missoula, Montana
1964-1970: (summers)	**Forestry Aide** U.S. Forest Service (Lolo National Forest) Thompson Falls, Montana

PUBLICATIONS/PROFESSIONAL PAPERS:

1991 **Potential Effects of Nutrient Control Measures in the Clark Fork Basin on Resident Fisheries.** Prepared for the Montana Department of Health and Environmental Sciences, Helena, MT. 36 pp.

1990 **Effects of Milltown Dam on the Clark Fork River Trout Fishery.** Prepared for the Montana Department of Fish, Wildlife and Parks, Missoula, MT. 37 pp.

1989
- a) **A Water Quality Evaluation of Lindbergh Lake and Recommendations for Further Study.** Prepared for the Lindbergh Lake Homeowners Association. 25 pp.
- b) **The Montana Department of Fish, Wildlife and Park's Missouri River Water Reservation Request Is in the Public Interest.** Prepared for the Montana Department of Fish, Wildlife and Parks, Helena, MT. 88 pp.

1988
- a) **An Assessment of Existing Groundwater Quality Data and a Suggested Monitoring Plan for the Helena Valley Aquifer.** Prepared for the Lewis and Clark City-County Board of Heath. 57 pp. Co-authored with Chris Deveny.
- b) **An Evaluation of Laws and Regulations that Protect Groundwater Quality.** Prepared for the Lewis and Clark City-County Board of Health. 44 pp. Co-authored with Chris Deveny.
- c) **A Description and Assessment of Funding Sources for Groundwater Projects.** Prepared for the Lewis and Clark City-County Board of Health. 21 pp. Co-authored with Chris Deveny.
- d) **Information for the Public Interest Portion of the Missouri River Water Preservation Application.** Prepared for the Montana Department of Fish, Wildlife and Parks, Helena, Montana. 36 pp.

1987
- a) **A Critique of the Water Quality and Trout Fishery Portions of the Kootenai National Forest Plan.** Prepared for the Cabinet Resource Group. 12 pp.
- b) **A Critique of the Water Quality and Trout Fishery Portions of the Gallatin National Forest Plan.** Prepared for the Montana Chapter, Sierra Club. 16 pp.

c) **A Suggested Approach for Controlling Nonpoint Pollution Caused by Forest Practices in Montana.** Prepared for the Clark Fork Coalition, Missoula, MT. 43 pp.

1986 a) **An Analysis of the Final Beaverhead Forest Plan Regarding Water Quality, Fisheries and Riparian Areas.** Prepared for Goetz, Madden and Dudd, P.C., Bozeman, MT. 27 pp.

b) **A Compendium of Ongoing Aquatic Resource Studies in the Clark Fork/Lake Pend Oreille Basin.** Montana Governor's Office, Helena, MT. 81 pp.

1985 a) **A Comprehensive Evaluation of Water Quality Issues and Reclamation Opportunities -- Clark Fork River Basin, Montana.** Montana Governor's Office. 38 pp. Co-authored with Howard Johnson.

b) **Clark Fork River/Lake Pend Oreille Basin Project -- An Aquatic Resource Evaluation and Work Plan.** Montana Governor's Office. 78 pp. Co-authored with Howard Johnson.

1984 a) **A Preliminary Assessment of Impacts to the Trout Fishery of the Upper Clark Fork River, Montana.** Prepared for the Montana Department of Fish, Wildlife and Parks, Helena, MT. 30 pp.

b) **Boulder River, Jefferson County, Montana. A Review of Impacts to the Trout Fishery and Initial Reclamation Recommendations.** Prepared for the Montana Department of Fish, Wildlife and Parks, Helena, MT. 25 pp.

c) **Prickly Pear Creek, Montana. A Stream Corridor Management Plan.** Prepared for the Jefferson and Lewis and Clark County Conservation Districts. 83 pp. Co-authored with **STREAMWORKS,** a Helena, Montana, consulting firm.

1981 **Needs in the Life of a Fish.** MONTANA OUTDOORS, May/June 1981. pp. 41-45.

1980 **Wildlife and Energy Development: Montana's Future Options.** MONTANA OUTDOORS. May/June 1980. pp. 31-37. Co-authored with Larry Peterman.

1979 **Pipeline Breaks: Oil and Wildlife Don't Mix.** MONTANA OUTDOORS. May/June 1979. pp. 37-41.

1978 **Upper Clark Fork River, Montana. Baseline Nutrient, Diel Dissolved Oxygen and Algal Accural Studies.** Montana Department of Fish and Game, Ecological Services Division, Helena, MT. 42 pp.

1977 a) **Mine Drainage Control from Metal Mines in a Subalpine Environment.** EPA-600/2-77-224. Prepared for the Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, OH. 168 pp. Co-authored with physical scientists from the Montana Bureau of Mines and Geology and Department of Natural Resources and Conservation.

b) **Disappearance of the Trout Fishery from Silver Creek Downstream from Mill Ponds Containing High Concentrations of Heavy Metals and Cyanide.** Montana Department of Fish and Game, Environment and Information Division, Helena, MT. 24 pp.

c) **The Saga of Silver Creek.** MONTANA OUTDOORS. Sept/October 1977. pp. 30-33.

1976 a) **Effects of Decreased Water Quantity and Increased Nutrient Additions on Algal Biomass Accumulation, and Subsequently, the Dissolved Oxygen Balance of the Yellowstone River.** Montana Department of Fish and Game, Environment and Information Division, Helena, MT. 22 pp.

b) **Gardening Without Pesticides.** MONTANA OUTDOORS. July/August 1976. pp. 2-6. (Reprinted in KANSAS WILDLIFE, May 1977.)

1975 **Causes and Probable Correctives for Oxygen Depletion Fish Kills in the Dickinson Bayou, Texas Estuary.** CONTRIBUTIONS IN MARINE SCIENCE, Vol. 19, pp. 37-48. Co-authored with Charles Belaire.

1974 **Mortality of Oysters (Crassostrea virginica), in Cedar Lakes, Texas.** Texas Parks and Wildlife Department, Environmental Branch, Seabrook, Texas. 21 pp. Co-authored with Charles Belaire.

1972 **Amphipod-Substrate Relationships in a Warmspring Slough.** Masters Thesis. University of Montana, Department of Zoology, Missoula, MT. 43 pp.

PREFILED TESTIMONY OF JOE C. ELLIOTT ON BEHALF OF THE MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

Q. Please state your name and business address.

A. Joe C. Elliott, 835 Eighth Avenue, Helena, Montana.

Q. By whom are you employed and in what capacity?

A. I am a self-employed ecological consultant working under contract to the Montana Department of Fish, Wildlife and Parks. As a self-employed ecological consultant, I work for clients in both government and the private sector. My clients include mining companies, pipeline construction companies, American Indian tribes, federal agencies, and state agencies.

Q. Please state your educational and employment experience.

A. I have a Bachelor of Science degree in biology from Wisconsin State University at Eau Claire and a Doctor of Philosophy degree in botany from the University of Montana. I conducted a year of post-doctoral research at Washington University in St. Louis, Missouri, studying the impacts of nitrogen fertilizer application on water quality in an agricultural region of Illinois. Following my post-doctoral studies, I joined the U.S. Peace Corps and taught crop physiology and ecology at the University of Nairobi in Kenya, East Africa.

Since returning from the Peace Corps, I have been a private consultant. I have worked as an ecological consultant for approximately 18 years throughout the western United States. I have conducted numerous studies on a wide variety of subjects including wildlife, vegetation, environmental impacts, mitigation of impacts, potentially irrigable lands, air quality, and wetlands. Projects on which I have worked are listed in the attached Professional Qualifications.

In addition to conducting studies and preparing reports, I have testified as an expert witness on the adequacy of environmental impact studies and on issues concerning historic management of forests and rangelands. As a consultant to the Montana Governor's Office, I evaluated impact studies prepared by the United States-Canada International Joint Commission for a proposed Canadian coal mine.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to discuss the direct and indirect benefits and costs of granting water reservations for instream flows in the Missouri River Basin. The direct benefits that I will address are tourism and recreation. Indirect benefits of the reservation pertain to hydropower production, pollution control, and

public health. Potential indirect costs relate to mining, agriculture, and municipal water supplies.

Q. What was your involvement in the Montana Department of Fish, Wildlife and Parks' (DFWP) "Application for Reservations of Water in the Missouri River Basin above Fort Peck Dam"?

A. I prepared a technical report for DFWP in January 1989 entitled "The Direct Benefits and Costs of Granting a Water Reservation for Instream Flows in the Missouri River Basin." Information in this report was included in portions of Volume 1 of the application from page 1-33 to page 1-81. A copy of the report is included in DFWP's Exhibit #5.

Q. What experience do you have which qualifies you to discuss these benefits and costs?

A. I have conducted numerous studies and prepared reports on various aspects of resource management and environmental assessment. These are listed in my biography, which is part of my testimony. My studies include gathering primary data and analyzing data and reports prepared by other resource specialists. I review and interpret published and unpublished data and reports on water quality, agriculture, mining, wildlife, biology, plant ecology, recreation, and other subject areas associated with natural resource management. My work includes making an assessment of the benefits and costs in analyzing choices to be made in resource management, including water resource management. My studies and reports have been used and relied upon by various government agencies, companies, Indian tribes, and others in making resource management decisions.

Q. What methods did you use to gather information and analyze the data and studies referred to in your testimony?

A. I contacted resource specialists in state and federal agencies and requested information relating to specific aspects of my testimony. I personally interviewed agency personnel at the Montana Department of State Lands (DSL), Montana Department of Health and Environmental Sciences (DHES), and at the Western Area Power Administration. I also obtained unpublished data directly from DSL and DHES files. Technical reports on tourism and recreation were obtained from the Montana Department of Commerce and from DFWP.

I aggregated and tabulated data to allow comparisons to be made between the upper and lower portions of the Missouri River Basin. I reviewed reports and used data from reports in coming to conclusions concerning benefits and costs.

Q. What direct benefits would be realized for tourism and recreation if the DFWP's instream reservation requests were granted?

A. Based on public opinion surveys conducted by Montana State University in 1984, more than 95 percent of non-residents surveyed perceived Montana as good or excellent in terms of the state's outdoor recreational amenities. Similarly, 91.3 percent of surveyed non-resident anglers reported Montana to have good or excellent fishing opportunities. The quality of Montana's natural environment is reflected in the fact that, in 1986, nearly 2.8 million non-residents visited Montana, generating over $475,000,000 in income for the state.

According to studies conducted by University of Montana economists and others in 1987, stream fishing in Montana was valued at $122,000,000 annually. Of this statewide value, the Missouri River Basin provides about 51 percent ($62,440,000) of statewide fishing-related values. In addition to fishing, recreational values also accrue from other activities such as floating, camping, hunting, bird watching, and photography. Recreational use of the Wild and Scenic portion of the Missouri River, excluding fishing, is worth about $5,883,000 annually. Similarly, floating on the Smith River is valued at about $1,160,000 annually. Other streams in the basin also provide water-based recreation in addition to fishing, but data are not available to accurately quantify these values.

A direct benefit of the reservation would be to help maintain the economic values of fishing and other water-based recreation within the Missouri River Basin. I did not analyze other direct benefits.

Q. What are the indirect benefits of the reservation?

A. Maintaining instream flows would provide indirect benefits for hydropower production, pollution control, and public health. These values also may be protected under existing rights or other reservation applications. Hydroelectric plants in the Missouri River Basin in Montana, North Dakota and South Dakota generate electricity as water flows through each facility. According to data from the Western Area Power Administration, the wholesale value of an acre-foot of water for electrical generation ranges from $5.83 to $10.88 per acre-foot of water.

The Corps of Engineers also provided an estimate for the value of an acre-foot of water passing through the same hydroelectric facilities on the Missouri River at $4.90 per acre-foot. The Chief of the Planning Division from the Corps of Engineers in Omaha, Nebraska, pointed out that the perceived benefits of hydropower are actually worth more than $4.90 per acre-foot. If new power sources must be brought on line, the cost would be 60 mils per kilowatt hour (KWH) or higher, or equivalent to about $41.00 per acre-foot.

Instream flow reservations would help maintain the electrical generating capacity of hydropower plants on the Missouri River.

Maintaining instream flows would help maintain existing water volumes to dilute wastewater discharges from municipalities and industrial sources as well as return flows from irrigation. In 1988, there were 43 municipalities, 46 industries, and 20 placer mining operations in the Missouri River Basin with discharge permits issued by the Montana Department of Health and Environmental Sciences.

Decreased streamflows could prevent industries and municipalities from discharging during periods of low flows if water quality standards were violated. Preventing industries and municipalities from discharging during low flow periods would pose serious operational and economic consequences. Either treatment facilities would need to be upgraded to reduce quantities of various chemical compounds and organic materials in wastewater, or effluents would have to be disposed of on land or some other means. Such measures would be extremely expensive methods of preventing damage to streams.

Instream flows would help reduce human health hazards resulting from high concentrations of arsenic originating from geothermal sources in Yellowstone National Park. Natural levels of this toxic element are diluted as flows increase downstream from the upper Madison River. Data collected by the U.S. Geological Survey in 1987 show that arsenic levels periodically exceed the federal drinking water standard in the Madison River below Hebgen Lake, below Ennis Lake, and at Three Forks. During the drought year of 1988, the mean arsenic concentration in August at Toston was nearly twice the federal drinking water standard. Arsenic concentrations were extremely high because of low flows in the Jefferson and Gallatin rivers. August 1988 streamflows were only 8 percent of the long-term daily mean flow in the Jefferson River and 60 percent of the long-term daily mean flow in the Gallatin River. Low flows in these rivers did not provide adequate dilution to prevent arsenic concentrations from exceeding drinking water standards.

Streamflow dilution provided by instream flows would help maintain safe drinking water supplies for municipalities that take drinking water from the Missouri and Madison rivers.

Q. What are the indirect costs of the reservation?

A. Indirect costs of the reservation could affect mining, agriculture, and municipal water supplies. Industry in the Missouri River Basin historically has been and continues to be dominated by mining and processing of mineral products. Mining in the Missouri River Basin provided 41.2 percent of salaries and wages paid throughout the state for mining in 1987. Salaries and wages in the Missouri River Basin for mining increased from $6,751,000 in 1981 to $19,813,000 in 1987.

Gold mines in the Missouri River Basin include placer mines, which are non-consumptive water users, and mines which extract gold from ore using chemical and physical methods. Quartz and limestone are quarried to produce cement, the processing of which consumes no water except for domestic purposes. Talc, gypsum, and chlorite mines consume little or no water in mining and processing.

Data from the Montana Department of State Lands indicates that metal mines in Montana utilize both groundwater and surface water to process ore. Approximately 72 percent of the ore mined in 1988 was processed utilizing groundwater.

The two largest metal mines in Montana obtain water to process ore from wells. ASARCO-Troy Mine and Pegasus Zortman-Landusky Mine both use about 1,700 gallons per minute (gpm) to process 60,000 to 80,000 tons of ore per day. The Golden Sunlight Mine near Whitehall uses about 700 gpm to process 35,000 tons of ore per day. The Golden Sunlight Mine obtains surface water for its ore processing needs.

Reservation of instream flows in the Missouri River Basin would have no impact (indirect cost) on existing mines or new mines utilizing groundwater, but they may affect future mining and ore processing if the new mines would rely entirely on surface water for consumptive purposes. Development of new mines requiring surface water possibly could utilize storage facilities or purchase existing water rights.

Revenues from agriculture in the Missouri River Basin are nearly equally provided by livestock and crop production. Average cash receipts from crops for the 7-year period 1980-86 contributed approximately 43 percent of the total crop resources. Similarly, livestock production in the Missouri River Basin provided about 43 percent of total state livestock revenues. Irrigated land in the Missouri River Basin comprises about 50 percent of all irrigated land in the state.

Instream water reservations would not affect existing agricultural water use in the basin, nor would they necessarily preclude the use of groundwater or water stored in off-stream reservoirs for the development of additional irrigation. Reservations could limit future expansion of irrigated agriculture if new surface water sources were needed.

Presently, 18 municipalities in the upper Missouri River Basin are planning to supply more water for commercial, residential, and industrial needs by the year 2025.

According to the Draft Environmental Impact Statement for Water Reservation Applications above Fort Peck Dam, prepared by the Montana Department of Natural Resources and Conservation, 18 municipalities have applied to reserve water in the basin. Of these 18 municipalities, six have applied to reserve water from streams for which instream flows also have been requested. The remaining 12

municipalities would acquire water from wells or from waters for which instream flows have not be requested.

Instream reservations would not conflict with those communities obtaining additional water from wells or from streams for which instream flows have not been requested.

Testimony provided herein is true and accurate.

DATED this __________ day of __________ 1991.

____
Joe C. Elliott

SUBSCRIBED AND SWORN to before me this ______ day of October 1991.

____
Notary Public for the State of Montana
Residing at Helena, Montana
My Commission Expires __________

DIRECT TESTIMONY OF JOHN DUFFIELD
UPPER MISSOURI RIVER BASIN WATER RESERVATION APPLICATION

PART I. OVERVIEW

Q. Please state your name and business address.

A. John Duffield, Department of Economics, University of Montana, Missoula, MT 59812 and Bioeconomics, Inc., 250 Station Drive, Missoula, MT 59801.

Q. What is your present employment?

A. I am a Professor of Economics at the University of Montana. I also work for Bioeconomics, Inc., a natural resource economics research firm.

Q. Please state your educational background and experience.

A. I was educated in Montana public schools through high school. I am a 1968 graduate of Northwestern University with a B.A. in economics. I received a Ph.D. in economics at Yale University in 1974, with a specialization in natural resource economics and market organization. I have been employed at the University of Montana since 1974, where I teach courses in resource and environmental economics, microeconomic theory and mathematical economics.

Q. Have you undertaken research on the value of the various uses of water including recreation?

A. Yes. My research focus for the last several years has been in the area of nonmarket valuation including many applications relevant to valuing water resources. In this period I have directed a number of studies for state and federal agencies including the Montana Department of Fish, Wildlife and Parks, the Montana Department of Natural Resources and Conservation, the National Park Service, the U.S. Forest Service, the U.S. Geological Survey and the Environmental Protection Agency. Many of these studies have examined both direct recreational use values as well as indirect or existence values for a number of resources. These include statewide elk, deer and waterfowl hunting and stream fishing values for Montana, studies of Rock Creek, the Big Hole River, the Bitterroot River, Nelson Spring Creek, and the recreational value of the Kootenai Falls hydroelectric site. Much of my recent research is concerned with the recreational value of instream flows. I have also directed a study of the value of water for irrigation use in Montana.

Q. Have you published articles or reports on your research in this area.

A. Yes. I have authored peer-reviewed reports, articles and reviews that have appeared in a variety of sources including the Journal of Environmental Economics and Management, Land Economics, Public Land Law Review, Water Resources Bulletin, Environmental Management and Advances in Applied Microeconomics.

Q. Have you previously served as an expert witness concerning the value of water or related energy resources?

A. Yes. My most directly relevant expert witness work includes: direct testimony on behalf of the Libby Rod and Gun Club in Libby Rod and Gun Club, et. al., plaintiffs v. Moraski et. al., defendents; direct testimony on behalf of the State of Montana on the Proposed Kootenai Falls Dam, Federal Energy Regulatory Commission, Project no. 2752; direct testimony on behalf of Missoula County, Colstrip Rate Base Proceedings, Montana Public Service Commission Docket No. 84.11.71; and direct testimony on behalf of Oregon Wildlife Federation on the Proposed Salt Caves Hydroelectric Project before the Water Policy Review Board, the Energy Facility Siting Council of the State of Oregon.

Q. Have you other experience that is relevant to the benefit-cost analysis of instream flow reservations?

A. Yes. An important issue in this case is the value of hydroelectric power. For a number of years I served on the Scientific and Technical Advisory Committee of the Northwest Power Planning Council.

Q. What is the purpose of your testimony in this proceeding?

A. I will provide an evaluation of whether Montana Department of Fish, Wildlife and Parks' (DFWP) application for instream flow reservations in the Missouri River above Fort Peck Dam (dated June 1989) is in the public interest.

Q. How do you define the public interest in this case?

A. I have followed strictly the criteria the Board of Natural Resources and Conservation (Board) is to use in these types of proceedings based on the Administrative Rules of Montana (ARM). The Board is required to consider a number of criteria including purpose, need, amount and public interest. My testimony is limited to the public interest criteria. The key elements of the public interest criteria are summarized in Exhibit 1.

Q. How have you organized your testimony?

A. I will first describe the Board's public interest criteria. I will then present my summary findings with respect to that criteria. My summary findings are compared to the analysis presented in the Montana Department of Natural Resources and Conservation (DNRC) Draft EIS on these reservations. Finally I will discuss in greater detail several specific irrigation projects and methods for valuing the recreation beneficial use. I have provided an outline of my testimony in Exhibit 2 and have labeled the corresponding sections of my testimony.

Q. Before proceeding further, can you briefly summarize your findings from applying the public interest criteria to the water reservation requests at issue in these proceedings?

A. Yes. I have identified the efficient allocation of water resources among competing uses and estimated total net benefits of this allocation. I found that 100% of the 21 municipal reservation requests are in the public interest with net benefits over 70 years (present value at 4.3% interest) of $380 million. For the conservation district requests, only 3% or 2 of the 220 reservation requests have project benefits in excess of direct and indirect costs. These projects are particularly costly in terms of foregone hydroelectric power generation, which I would suggest be valued at a replacement cost of 75 mills per kilowatt hour. For DFWP's instream flow reservation requests for which there are competing consumptive uses, I found that an allocation of 89.3% of the reservation requests (47 DFWP reservations affected) were in the public interest with net benefits of $604 million. For DFWP's reservation requests with no competing uses, of which there were 232, 100% of the reservations are in the public interest with net benefits of $697 million.

Q. Are these results summarized elsewhere in your testimony?

A. Yes. I provide a summary discussion at the end of my testimony. The numbers referenced here are shown in my last exhibit, Exhibit 33.

Q. Have you examined the purpose, need or amount for these reservations?

A. No. I have limited myself to the public interest criteria. Accordingly the summary results for all the reservation requests assume that the criteria of purpose, need and amount have been addressed. For purposes of my analysis I have assumed that all reservations, including the municipal and conservation district ones, would proceed expeditiously and would be in place for purposes of the 70 year present

worth analysis. In other words, I have not tried to second guess need, feasibility or timing but take all reservations at face value. If there is some reason to believe, for example, that all of the conservation district or municipal projects could not be in place in the very near term, the benefits for these projects are overstated in my analysis.

PART II. BOARD'S PUBLIC INTEREST CRITERIA

Q. What are the specific elements of the public interest criteria?

A. The public interest criteria basically requires evidence that the "expected benefits of applying the reserved use are reasonably likely to exceed the costs" (Exhibit 1). Equivalently, the net benefits of a reservation must be greater than zero. Net benefits are simply: NET BENEFITS = DIRECT BENEFITS + INDIRECT BENEFITS - (DIRECT COSTS + INDIRECT COSTS). Each of these elements is defined in Exhibit 1. An important element here is that indirect costs include "the economic opportunity costs that the requested flow may have to parties other than the reservant" (ARM 36.16.105C (b) and Exhibit 1).

Q. What does this mean in the context of this proceeding?

A. As shown in Exhibit 3, in order to establish the net benefits of DFWP's proposed instream flow reservation it is necessary to add up the value of fish and wildlife uses and recreation use which are the direct benefit in this case (given DFWP's role as a trustee for these public uses) plus the indirect benefits that unavoidably accrue to instream flows including hydropower and water quality and subtract the direct costs (DFWP's administrative costs, if any, that are a positive function of flow levels) and subtract the indirect costs. The latter include any competing consumptive uses such as irrigation or municipal uses that are foregone because of DFWP's instream reservation (see Exhibit 3).

Q. Does this mean that in order to evaluate DFWP's reservation for fish and wildlife and recreational purposes you have to also examine all other beneficial uses at issue in this proceeding?

A. Basically, yes. Clearly one needs to examine the indirect benefits to hydropower and the indirect costs to municipal and irrigation uses.

Q. Would the same be true of a public interest or benefit/cost evaluation of the consumptive reservations in this proceeding?

A. Yes. This would be true for irrigation reservations because from the standpoint of consumptive uses, the indirect cost of withdrawing water for irrigation is the foregone use of this water for recreation, fish and wildlife, hydropower and water quality uses, all of which are potentially significant costs. For irrigation, this is illustrated in Part B. of Exhibit 3 and for municipal withdrawals in Part C.

Q. Suppose there are just two competing uses, say instream use versus a consumptive use such as irrigation. By doing a thorough job of examining the problem from the standpoint of one competing use, do you then have a result that is also decisive from the standpoint of the other use?

A. Generally, yes. For example, suppose you have direct and indirect benefits of instream flow uses for a given amount of water totaling $100. If the only cost of this water is a foregone consumptive use for irrigation worth, say, $75, then the net benefit is positive and worth $25. This suggests in this simple hypothetical that the instream reservation is in the public interest as defined in the ARM. Conversely, if the analysis was done from the standpoint of the equal amount of water being used for irrigation, the benefits of $75 are outweighed by the costs of foregone instream uses, perhaps recreation and hydropower, worth $100. Accordingly, the net benefits of the irrigation reservation in this simple hypothetical is a negative $25, which suggests the irrigation reservation would not be in the public interest. The symmetry of these results is logical and not surprising, given that the items in Exhibit 3(A) for an instream use and Exhibit 3(B) for a consumptive use such as irrigation are identical, just the sign (minus or plus) of the entry is changed as to whether it is now a cost or benefit.

Q. Does the ARM define the public interest criteria to be defined totally by a benefit-cost evaluation?

A. No. The ARM rule requires that the Board make specific findings on the public interest factors listed, but the rule does not require that any of the criteria be specifically met. In fact, the rule provides that the Board is to use "its judgement and discretion" in determining whether a reservation is in the public interest "based on a weighing and balancing" of the listed factors. Nonetheless, I will be focusing my testimony on the benefit-cost evaluation.

Q. Is it possible to identify market prices for all relevant uses?

A. No. It is important to note that the criteria (Exhibit 1) include not only market but also nonmarket values. For

example, my valuation of the recreation use is largely a nonmarket one (see Part VII below). Nonmarket values are dollar estimates of the value of items that are not traded in established markets. Additionally, the regulation requires that "benefits and costs that may not be reasonably quantified are considered".

Q. What does the latter imply?

A. This means that the benefit/cost results should be interpreted with respect to unquantifiable factors. For example, suppose that the dollar values of instream uses and, say, irrigation were identical for a given amount of water. Suppose that there was an important benefit, perhaps on the instream side, that could not be quantified. An example in this connection might be the indirect benefit of DFWP's instream reservation for the dilution of arsenic concentrations as noted in the Department of Health and Environmental Sciences (DHES) application. If there were no other important factors, this might indicate that the instream flow reservation was in the public interest.

Q. Do you evaluate the DFWP instream flow reservations individually or as a group?

A. I approach this problem in both ways. In the following section of my testimony I discuss the aggregate benefit-cost results. In this analysis, one can compute, for example, the net benefits of the entire group of irrigation reservation requests or the entire group of municipal requests. One can also examine subgroups of these reservations that reflect different allocations of water among the competing claims.

Q. Why would you examine different subgroups of reservation applications?

A. To satisfy the public interest criteria (Exhibit 1, item 4(b) and 4(c)) it is necessary to identify the set of reservation requests, that is to say the combination of competing municipal, irrigation and instream reservations, that yields the highest net benefits. Otherwise, one could argue that an alternative remains that is superior. Economists would call this net benefit maximizing set of reservations the most efficient combination or the one that results in the optimal allocation of water among competing uses.

Q. How does one identify the most efficient combination of reservation requests?

A. This has to be done by comparing each of the individual competing sets of requests at the project and instream reach

level, both for municipal and irrigation requests.

Q. Have you undertaken such an analysis?

A. Yes, I will also describe our project level analysis in Part III. In fact the aggregate level results are built up from the project level analysis. I present the aggregate results to provide an overview of findings.

Q. How many specific reservation requests do you analyze?

A. I have analyzed the 220 specific water reservations for irrigation use put forward by the Conservation Districts, 21 municipal reservations, and 283 instream flow reservations applied for by DFWP. All of the 241 consumptive use requests (irrigation plus municipal) compete with one or more of 47 specific DFWP instream flow requests. Most of my analysis and testimony concerns these competing reservations. However there are 232 DFWP instream flow requests for which there are no indirect costs of foregone irrigation or municipal uses. I analyze this group of requests separately. For this latter group, assuming direct costs are negligable, it is only necessary to show some positive benefits, for example to recreation or hydropower, for these uses to be in the public interest. Additionally, there are 4 DFWP instream flow requests where it is not clear whether there are competing reservations or not (see Exhibit 12, item 1).

Q. How have you measured the benefits of application of water to the various beneficial uses?

A. I have followed the economic procedures outlined in the federal benefit-cost guidelines for evaluation of water development projects. These are contained in the U.S. Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (1983). I have followed these procedures because they are valid and widely accepted and have evolved through close examination within the economics profession. I have also relied on the published economics literature as a guide to current practices. I will describe the specific conceptual and methodological basis for my estimates in a discussion of each specific beneficial use.

PART III. VALUES PER ACRE-FOOT

Q. How did you analyze the benefits and costs for the proposed irrigation, municipal and instream reservation requests?

A. For every reservation request I followed the Board's public interest criteria and identified in general terms the relevant categories of benefits and costs derived from that

criteria and as specified in Exhibit 3. I then followed a three step procedure. 1) I identified the value of an acre-foot of water in each of these alternative beneficial uses. 2) Then I identified the amounts of water that would be applied to each beneficial use in a given reservation. 3) Finally, I multiplied the values per acre-foot of water (dollars/acre-foot) times the acre-foot quanities at issue and thereby obtain dollar value benefits, costs and net benefits for each reservation.

Q. How did you do your step 1), deriving acre-foot values for each of the uses?

A. I provide detailed discussions of how I derived values per acre foot for the recreation beneficial use in Part VII. Here I will summarize the methods used for all beneficial uses and present representative values per acre-foot.

Q. What were the summary values per acre-foot that you found?

A. These are shown in my Exhibit 4. The first item shown is hydropower values. The kilowatt-hours of electric energy that a given acre-foot of water can generate is a function of how many feet of head the given acre-foot of water will drop as it goes through generating plants on the Missouri and tributaries. The value per kilowatt-hour is generally based on the cost of the least cost alternative source of that electric energy. For example (Exhibit 4), an acre-foot of water that is in the headwaters of the Missouri, such as the upper Madison River, if left instream will go through 11 dams in Montana, including Holter and Fort Peck and 5 more dams futher downstream and generate a total of 1383 kilowatt hours. At 5 cents per kilowatt hour this is $69.16. If that acre-foot is diverted from the Madison and consumed, the $69.16 worth of electric energy is lost and must be replaced, perhaps by a coal-fired generating plant. I show a range of $69.16 to $138.32 corresponding to alternative assumptions on the cost of replacement power ranging from 50 mills per kilowatt hour to 100 mills.

Q. What is the correct value for replacement power?

A. In the analysis that follows, it is necessary to project values into the future. An analysis of this issue was undertaken by Montana Department of Natural Resources and Conservation and summarized in a Draft Environmental Impact Statement on Missouri River Basin Water Reservation Applications above Fort Peck Dam (hereafter "DNRC EIS"). In the DNRC EIS, a future time horizon of 70 years was used and I have followed that convention. While the costs of new electric power resources may average around 5 cents or 50 mills at present, the real long term levelized cost of new

power sources over 70 years may be 50 mills to 100 mills. This is the range suggested in the DNRC EIS. I think this is a reasonable range, based on the cost of new resources and with a discount rate consistent with that used in the DNRC irrigation analysis. Given the importance of the electric power value, I show the sensitivity of all key results to the range of 50, 75 and 100 mills in the summaries that follow.

Q. What is the foregone hydroelectric power value of an acre-foot withdrawn further down the Missouri?

A. As shown in Exhibit 4, for water withdrawn, for example, below Belt Creek and below the major Montana Power dams near Great Falls, the value at 50 mills drops to $30.38, because there are now fewer dams for the water to go through.

Q. What are the values per acre-foot you use for recreation?

A. These are derived in detail in Part VII and summarized in Exhibit 4. The values are based on the recreationist's estimated willingness to pay for recreational experiences. The specific values shown here are derived from surveys that measure recreationist's responses in hypothetical market settings. This work is carefully explained in Part VII and is shown to be consistent with values derived from examining observed behavior in the related market for recreational travel. This work is also supported by actual market prices in fee fishing settings such as Nelson's Spring Creek ($40 per day in the summer) and Red Rocks River ($45 per day). Like hydropower, the foregone value of recreation depends on where in the basin the water is diverted and during what time of year. For example, an acre-foot in the headwaters has a value of $60.67 for recreation in July-August but an acre-foot withdrawn near Fort Benton at another time of year might only result in losses of $1.63. These values reflect the fact that rivers in the headwaters such as the Madison, Gallatin and Big Hole are very heavily used. Just like for hydropower, the water high in the basin will flow through many recreation "facilities" or sites and maintain fish populations and adequate flows for recreation all the way down the river.

Q. What do you use for an average value over the year?

A. It depends on the nature of the diversion. For a municipal withdrawal which might be approximately continuous over the year (except for watering), one might average the values in Exhibit 4 on a monthly basis (July and August plus 10 other months). The average shown is assumed representative of the withdrawals expected for the irrigation projects at issue in these proceedings, as based on DNRC EIS table 6-41 (see

Exhibit 18 below).

Q. What are the combined instream flow values you have found per acre-foot?

A. Because an acre-foot of water diverted and consumed from the river affects both hydropower and recreation, these values can be combined. Combined values at 75 mill replacement cost of power are shown in Exhibit 4 and total $154.11 high in the basin and $49.64 lower down.

Q. What values have you used for irrigation projects?

A. These values are based on a detailed analysis of each project. This analysis was undertaken by John Tubbs, Bill Greiman and Dan Dodds at Montana DNRC and is summarized in DNRC EIS Appendix Table K-4 (see Exhibit 16 below). A more detailed discussion of the model is in Tubbs, Greiman and Dodds, "DNRC Water Reservations Economic and Financial Evaluation Irrigation Projects" (June 1989). The irrigation analysis is also described more fully in Part VI below, which examines several specific projects. Basically it was assumed that most projects would grow alfalfa based on the greater profitability of alfalfa production. An eight year rotation was assumed with one year of grain as a nurse crop. A price forecasting model was developed based on historical averages corrected for inflation and tied to the market for calves. Costs were based on recent estimates specific to Montana. Using the price model, 300 future scenarios were run for each project and the value reported (DNRC EIS Appendix Table K-4) is a median value. The average in DNRC's analysis is $42 per acre-foot consumed (Exhibit 4), based on assumed power costs to the irrigator of 40 mills or 4 cents per kilowatt hour.

Q. Do these values depend on any assumptions about the efficiency of the irrigation system?

A. Yes, given the project benefits, one needs to compute the acre-feet actually consumed by crops or otherwise irretrievably lost. For example, suppose a project has annual benefits of $50,000 and diverts 1000 acre-feet. If all of this water is consumed or irretrievably lost, then the project returns $50 per acre-foot consumed and has other costs associated with 1000 acre-feet of foregone instream (hydroelectric and recreation) uses. But if the project consumes only 500 acre-feet, then benefits per acre-foot are $100 and return flows are 500. In this case foregone instream use is only half as high.

Q. What did DNRC assume?

A. DNRC assumed 50 percent return flows on all projects in their analysis as reported in DNRC EIS Appendix K.

Q. What are the irrigation values that result from other return flow assumptions?

A. I show in Exhibit 4 irrigation benefit values that are more closely based on the DNRC water availability model. These average $26 per acre-foot. The return flow approach is as follows. Based on discussions with DNRC hydrologists, including Larry Dolan and Larry Cawlfield, a better general assumption would be to assume 75% efficiency for sprinkler irrigation and 50% for flood irrigation. Additionally, the return flows are likely to be reduced by 15% for water irretrievably lost so that return flows are about 21% (.85 times 25%) for sprinkler and about 43% (.85 times 50%) for flood. Also, many of the irrigation projects are on benches above and distant from the given stream or river where the diversion occurs. In some of these cases it will take many years for a large soil zone to be saturated and result in any return flows. In a present value setting, it is appropriate to take these return flows at zero. A specific set of such projects was defined for us by Larry Dolan. We also obtained estimates of specific amounts of water consumed on projects GA-46 and GA-201 from John Goroski at DNRC.

Q. Are there further refinements that could be made to the analysis?

A. Yes. One could examine actual return flows for every project. It has not been possible for me to do that.

Q. Can you provide a specific example of the importance of the return flow assumption for a given irrigation project?

A. Yes. But I will do this later in my testimony in conjunction with Exhibit 17.

Q. Do the average irrigation benefits depend on the cost of power?

A. Yes. While 40 mills may be appropriate for a financial or feasibility analysis from the standpoint of the irrigator, it is not appropriate for a benefit-cost analysis where the real replacement cost of the power over 70 years may average much higher. It is somewhat arbitrary whether one subtracts out the social cost of power as a direct cost or later as an indirect cost line item. I have used the latter approach.

Q. What are the municipal use values?

A. Municipal values are based on DNRC's analysis. Municipal water was valued at $590 per acre-foot (DNRC study, Table K-4) based on the price individuals pay for municipal water in Helena ($2.47 per 1000 gallons) and the average direct costs of municipal systems in Montana ($.67 per 1000 gallons).

Q. How do these average values compare across municipal and instream uses?

A. Clearly municipal has a value that is about four times as high as even the most valuable instream flow acre-feet in reaches high in the basin. Accordingly, these reservations will all easily pass a public interest benefit-cost test.

Q. How do values compare across irrigation and instream requests?

A. This will depend on where the specific diversion is located and on the project-specific benefits. However, given that the range of values for instream uses is from $50 to $150 dollars while the average for irrigation projects is only $42 even under the most favorable assumptions, it is not likely that many irrigation projects will pass a benefit-cost test.

PART IV. SUMMARY OF FINDINGS - PUBLIC INTEREST CRITERIA

Q. What are the net benefits for the various reservations that you have analyzed?

A. This question moves us on to Step 2 and 3 of the analysis. I have organized this part of my testimony in two parts. First I will discuss the consumptive use reservations, including municipal and irrigation. Secondly, I will discuss the net benefits associated with DFWP's reservations for which there are no competing consumptive uses.

Q. How have you identified the amounts of water to multiply times the acre-foot values of Exhibit 4?

A. Where there are competing uses for water, it is most convenient to base the anlysis on the consumptive use project water reservation amount. This is because a given diversion can affect any of a number of reaches. I have not attempted to identify the specific DFWP reservations affected by a given consumptive use. For the DFWP reservations with no competing consumptive use, I have aggregated noncompeting instream reservations at the subbasin level and derive only approximate values. A more refined analysis would require a more elaborate accounting system and does not appear justified for these cases, given the absence of competing uses.

Q. Based on the values per acre-foot that you show in Exhibit 4, what are your findings as to the number of irrigation projects that pass a benefit-cost test?

A. In Exhibit 5 I provide a summary of the number of irrigation projects with positive net benefits based on using the full set of benefits and costs required by the public interest criteria (Exhibit 3). The number of projects with positive net benefits depends on the assumptions regarding the cost of replacement power. In Exhibit 5 I shows the results of an analysis with 50 mill power and 50% return flows (Scenario A which is similar to DNRC's) and then Scenarios B,C, and D based on 50, 75 and 100 mill power respectively and return flows of 21% for sprinkler (or zero), 43% for flood, plus specific amounts for projects GA-46 and GA-201 as shown in Exhibit 17. The basic finding is that out of 220 irrigation projects, the number that pass for Scenarios A,B,C, and D are 47, 11, 2 and 2, respectively out of 220 projects.

Q. Do these findings surprise you?

A. No. The Missouri headwaters and mainstem at least as far down as Cascade are among the premier trout fisheries in North America. On some reaches like the Madison nonresident anglers are 75% of all users in the summer months. These are destination fisheries in the same sense that Big Mountain and Big Sky are destination ski areas. This river is also one of the most important hydroelectric resources in the U.S. By contrast, agriculture in Montana is a mature industry. A lot of very practical and thoughtful farmers and ranchers have had over a 100 years of trial and error to find the sites that make sense for irrigated agriculture in this state. The projects that are now proposed are generally marginal sites, which is to say the costs of development are high. If they made a lot of sense, they would probably already be in production. If they didn't make sense in the past, it is not clear why they would make sense now given increasing real costs of electricity and stable to declining real long term prices for many agricultural products. Many of the sites involve fairly expensive sprinkler irrigation systems and pumping of water over substantial distances and elevations. Several specific cases are described later in conjunction with Exhibit 17.

Q. Have you estimated the aggregate benefits and costs associated with alternative allocations of water among the reservation alternatives before this proceeding?

A. Yes. The aggregate results of my analysis are shown in Exhibit 6 for municipal and irrigation projects. I show the results for what in the DNRC EIS is called the "Consumptive Use" alternative which would entail a reservation for all

220 irrigation projects and 21 municipal reservations. I also in this Exhibit show the allocation across consumptive and instream uses that would be "efficient" or with the highest net benefits.

Q. What are your findings for the consumptive case?

A. I will first discuss the municipal reservations which include a total of 34,659 acre feet. At $590 per acre-foot (Exhibit 4), this is a value of about $20.5 million per year. The present value of $20.5 million for 70 years at 4.3% discount rate is $452.12 million.

Q. What do you mean by present value?

A. Present value is the lump sum equivalent in present time of some annual stream of value. For example, suppose you could buy a $100,000 house and finance it at 4.3% interest for 70 years, obviously not a typical mortgage arrangement. This would amount to a payment of $376.91 a month or $4522.90 a year for 70 years to cover principle and interest. Conversely, the present value of $4522.90 a year for 70 years at 4.3% is $100,000. Similarly we can compute the relationship of the annual value of $20.5 million for municipal water use to the present value of that stream of value at $452.12 million. I use a value of 4.3% here because this was used in the DNRC EIS and is a reasonable value to use for a discount rate that excludes inflation (real terms). For example, this is similar to the value for a social discount rate suggested by R.C. Lind in Discounting for Time and Risk in Energy Policy (John Hopkins University Press, 1982).

Q. What is the net present value of the annual net benefits for municipal reservations.

A. In this case all of the municipal reservations would be granted on a narrow public interest criteria. The benefits are $452.12 million but the costs are about $9 million in foregone recreation and $64 million in hydropower losses. Clearly net benefits are very substantial for these reservations. DNRC has raised questions about the amounts requested by these municipalities and I have not addressed that issue.

Q. What are your findings of net benefits if all irrigation reservations are granted?

A. In this case, the present value of benefits to irrigation are $144 million, but even at 50 mills, the costs of replacement power total $34 million and foregone hydro generation is $338 million. In addition foregone recreation

totals $103 million. Net benefits to the entire set of irrigation projects are large and negative at minus $322.25 million. In other words, the benefits are far exceeded by the costs and these reservations taken as a whole are not in the public interest.

Q. In reference to your earlier discussion of the symmetry of benefits and costs whether from the standpoint of the consumptive or the instream use, what does this show for the net benefits of an instream reservation that would keep in the river the proposed diversions?

A. The net benefits would be very large and positive and equal $322 million; in other words, the value of the water left in the river far exceeds the cost of foregone benefits to new irrigated agricultural production.

Q. Do these results vary with the assumed cost of power?

A. Yes. At more realistic levels of the levelized replacement cost of power over 70 years, the negative net benefits of the "Consumptive Use" alternative for irrigation increase in magnitude to minus $588 million to minus $844 million at 75 and 100 mill power respectively. The corresponding net benefits to the instream use of this water has the same magnitude but the opposite sign.

Q. Do these results seem very defensible to you?

A. Yes. I think the recreation values are the most difficult to explain and understand. But it is very hard to argue about the amount of water that goes or does not go through a turbine and the "cost" of that power is an issue that is closely examined and debated in many public forums including the Montana Public Service Commission and the Northwest Power Planning Council. Even in the lowest power cost scenario presented, that for 50 mills over 70 years, the costs related to hydroelectricity alone (estimated at $381 million in Exhibit 6, item C) are more than double the irrigation benefits at $143 million.

Q. Are there other important uses which you have not quantified?

A. Yes. As required by the Board decision criteria specified in ARM 36.16.107B, "benefits and costs that may not be reasonably quantified are considered". There are possibly substantial fish and wildlife and water quality values here that, as I have indicated in Exhibit 6 with a minus sign ("-"), are additional costs of irrigation but are not quantified. For example, one of the specific irrigation projects (GA-201) would pump water from the Madison River to

irrigate 7,890 acres of benchland. This water will have very high arsenic levels and almost certainly lead to eventual arsenic concentrations in the groundwater in excess of federal drinking water standards. These kind of effects are likely based on a detailed study by John Sonderegger and Takeshi Ohguchi described in "Irrigation Related Arsenic Contamination of a Thin, Alluvial Aquafir, Madison River Valley, Montana, U.S.A." (Environ. Geol. Water Sci. Vol. 11, 1988). There are real costs involved in such a contamination in terms of health risks, but I have not tried to compute them.

Q. Are there unquantified costs to fish and wildlife resources?

A. Yes. There are values associated with fish and wildlife that do not require direct recreational use. For example, some individuals place a value on knowing that endangered species of wildlife or fish can exist at viable population levels. The fact that people donate to trust funds, such as those of the Nature Conservancy or the World Wildlife Fund or Defenders of Wildlife or the Rocky Mountain Elk Foundation for the protection of species or populations they may never directly see or use is evidence that these values are real.

Q. Are there other important indirect benefits or costs at issue?

A. Yes. I think it is important to recognize that existing agricultural users will likely benefit from an instream reservation. If nothing else, an instream reservation makes it less costly to maintain adequate flow into a headgate. By contrast, new irrigation diversion would lower flows.

Q. If instream reservations are in the existing irrigators' interest, why would the agricultural community oppose the instream reservations?

A. I think that many irrigators do not understand that DFWP's instream reservations will have a priority date of July 1, 1985 and are therefore very junior rights. There is a fear that in drought years DFWP will have the right to cut into the flows available to existing senior rights holders. My understanding is that this is not the case.

Q. Are there other considerations that support your basic finding that the benefits of additional irrigation reservations on aggregate are outweighed by the costs of foregone costs hydroelectricity and recreation?

A. Yes. In doing the present value computation I have assumed that the value per acre-foot for recreation is constant over the next 70 years. In fact there has been a fairly

substantial increase in river-related participation in the past and it may be reasonable to project it into the future. Recently there have been steady increases in the use of some rivers, such as the Smith, where a fitted trend line shows an average increase of about 10% a year from 1984 to 1990 (see Exhibit Rec-12).

Q. Is it possible that expanded irrigated agriculture could depress prices?

A. Yes. I have made no attempt to correct the price forecast for the response of the price per ton of alfalfa to exapanded supply, even though the effect could be substantial in this case. In the DNRC EIS (p. 83) it is noted that "Irrigated alfalfa acreage in the basin above Fort Peck has averaged about 135,000 harvest acres over the past 20 years." My understanding is that around 65% of the new production associated with the 212,000 some acres of conservation district proposals is alfalfa and hay. This implies a possible doubling of the current harvested acreage. The aggregate market effect of these projects may be such that the irrigation benefits as calculated may be overstated. Alternatively, perhaps these aggregate market effects, fit better under the criteria of "need".

Q. Having analyzed the basic "Consumptive Use" case in your Exhibit 6, what are the findings for your "Efficient" cases?

A. Here I have separated out the share of irrigation projects that "pass" and "don't pass" the benefit-cost test, depending on the assumed value of hydropower. For example, under 50 mill power, there are 11 projects with benefits greater than costs, as shown in Exhibit 6. Similarly there are 209 projects that don't pass; for these costs are greater than benefits. The largest possible net benefits are achieved by granting water reservations to projects that pass and keeping the remaining water instream.

Q. Which value of hydropower should be used?

A. Based on my discussions with individuals working in the utility sector, I think that 75 mill power is the best estimate.

Q. Can you briefly describe which projects are economic at this replacement power cost?

A. At this value for power there are two projects that pass. Net benefits are positive for LM-20 at $78.69/AF and TE-591 at $19.53/AF.

Q. What allocation of water reservations between irrigation

projects and DFWP's instream flow requests appears justified on the grounds of public interest narrowly defined in terms of quantifiable benefits and costs?

A. As noted, there are two projects, LM-20 and TE-591, where benefits are consistently above costs across the scenarios examined. The net benefit of these two projects even against 100 mill power (Exhibit 6) is 6.55 million. I would allocate the remainder of the reservations for which there are competing uses to instream uses. This results in net benefits from the instream use of about $600 million.

Q. Have you documented your computation of these aggregate values?

A. Yes. Exhibit 7 shows the computer results for all 220 irrigation projects as well as the municipal reservations for the 75 mill power case. Exhibit 8 provides the data base used in these computations and Exhibit 9 is the computer code. Exhibit 8 is derived from the DNRC EIS Appendix K-3 Table of irrigation project benefits plus the diversion amounts from Table 3-1 and project specific information on projects with zero returns. We also coded in whether the project was sprinkler or flood irrigated from the individual project Environmental Assessments.

Q. Have you investigated the net benefits to the DFWP reservations for which there are no competing uses?

A. We have made only a preliminary analysis of these cases. Recall that there are a total of about 283 DFWP reservations requests. Only 47 of these have clearly competing uses and those are the ones we have just finished discussing. There are 4 cases where the classification is not clear (Exhibit 12). For the remaining 232 reservations, it is only necessary to establish that there are some benefits, as discussed earlier. I would suggest that these reservations will have some recreation benefits given the logical connection between fishery production levels and recreation and the relationship of fisheries to streamflow. The latter is demonstrated for each reach by DFWP in the June 1989 application. The connection of recreation to fishery production has been established in the recreation economic studies referenced below in Part VII, for example in the statistical relationship between catch rates and participation levels.

Q. Have you made a preliminary estimate of the net benefits associated with these 232 reservations?

A. Yes. I developed a data base of total acre-foot reservation requests for this group from Table K-3 and Table 3-2 in the

DNRC EIS. In Exhibit 10 we show the acre-foot reservations for a reach near the mouth of each major river in a given subbasin, for example Reach #3 for the mainstem Big Hole in the Big Hole subbasin. We also show the ratio of acre-feet of water in the reservation at the mouth compared to the annual flow at the mouth based on the nearest U.S. Geological Survey long term guage. If a similar ratio of flows in all reaches in the subbasin were being reserved, this ratio would indicate an average share of total recreational value in the subbasin associated with the subbasin reservations. We also show in Exhibit 10 the total net economic value associated with just fishing in each subbasin based on Duffield, Loomis and Brooks 1987 (DFWP Exhibit 7). This ignores other river-related recreation in the basin and totals about $62 million per year. Based on the ratio of protected flows shown in Exhibit 10, net benefits associated with the reservations could be $32 million (the sum of "CALC" in Exhibit 10) or a net present value of $697 million. We also show in Exhibit 10 the tributary flows protected in the subbasin, also as a ratio to total annual flows out of the subbasin.

Q. Is granting the DFWP reservations for which there are no competing uses in the public interest?

A. Yes, it appears so. For these reservations there are no indirect costs and direct costs are negligable. Since recreation benefits are positive and possibly on the order of $32 million annually and because there are potentially significant unquantified benefits including water quality and fish & wildlife uses, it appears that these reservations as a group are in the public interest.

PART V. COMPARISON TO MONTANA DNRC SUMMARY

Q. Are there any published evaluations applying the public interest criteria to any of the instream flow reservations in this proceeding?

A. Yes. As noted earlier, there has been a fairly comprehensive analysis conducted by the Montana Department of Natural Resources and Conservation that we have referred to as the DNRC EIS. This document was issued in June of 1991 and is 255 pages long plus over 100 pages of appendices.

Q. From what standpoint was the DNRC analysis conducted with regard to your definitions of benefits and costs in Exhibit 3?

A. The analysis was undertaken from the standpoint of the consumptive use reservations, specifically irrigation reservations by Montana Conservation Districts and municipal

reservations by Montana municipalities. DNRC did not specifically analyze DFWP's 232 reservations for which there are no competing uses.

Q. Did DNRC's analysis of indirect costs include the foregone benefits of hydroelectric power and recreation that would accompany competing consumptive withdrawals for irrigation or municipal uses?

A. Yes. The analysis generally included the elements (and in the right categories) as detailed in my Exhibit 3(B) and 3(C) for irrigation and municipal withdrawals. I might note that fish and wildlife uses as distinct from direct recreational use of these resources were not quantified, nor were the indirect costs of reduced water quality quantified. The analysis was limited to recreation, irrigation, hydropower and municipal beneficial uses.

Q. Were there any problems with the DNRC benefit-cost analysis?

A. There are some problems, though their general approach was sound. In our review of this work we found a number of basically accounting types of errors. These are listed in Exhibit 11. We also found some minor typographical and arithmetic errors that we report in Exhibit 12 for purposes of developing a record of why the estimates we present differ in some cases. I would note that the DNRC EIS represents an impressive amount of work, much of which is very carefully done. This is a Draft EIS and the purpose of releasing a draft is to catch these types of errors.

Q. Will you discuss the basic findings of the DNRC EIS with regard to the public interest criteria?

A. Yes. I will first describe the summary of their findings and then return to Exhibit 11 and go through each of the main issues one by one.

Q. Where are the basic findings of the DNRC study summarized?

A. The results are summarized for each of the individual irrigation and municipal reservations in Table K-4 (Appendix K of the DNRC study) (see Exhibit 16). The aggregate results are summarized in Tables S-1 and S-2 which appear in the initial Summary section of the DNRC EIS and which are reproduced in Exhibit 13. In Table K-3 of the EIS there are listed the 232 DFWP reservation requests with no competing consumptive reservations. The focus of the DNRC study is entirely on the reservations with competing uses.

Q. What are the basic aggregate findings of the DNRC study?

A. DNRC totaled up benefits and costs for their enumeration of 220 specific irrigation and 19 municipal reservation requests (several reservations by the same municipality were combined). In every case for these there was a competing instream reservation request from DFWP. At $590/acre-foot values, it is not surprising that the 19 municipal reservations were found to be more valuable compared to competing instream uses, with the net present value of benefits of $343.2 million over 70 years (using a 4.3 percent discount rate) compared to the cost of foregone recreation and hydropower benefits of only $1.9 million (Exhibit 13). Net benefits for municipal reservations, which do not require great amounts of water generally, are clearly very large (Table S-2 in Exhibit 13). In short, DNRC found the municipal reservations to be in the public interest and focused their analytical effort on the allocation of water between irrigation and instream uses.

Q. What allocations of water did DNRC analyze for irrigation reservations?

A. This case is more complicated since the value per acre-foot of water for irrigation, hydropower and recreation depend on site specific factors and therefore vary from project to project and reach to reach. DNRC approached the problem by looking at three different specific allocations of the water reservations at issue. Under one allocation, called the "Consumptive Use" alternative as noted previously, all consumptive use applications would be granted leading to 212,209 acres of new irrigation. The next allocation, "Combination", includes all municipal reservations plus irrigation projects that are at least break-even financially feasible resulting in 133,294 acres of new irrigation. Lastly, DNRC examined an "Instream" allocation, with a higher priority to instream reservations resulting in 46,950 acres of new irrigation. DNRC did not examine a complete instream alternative (eg. status quo or no new consumption).

Q. What did DNRC find with regard to the irrigation reservations?

A. The basic finding is that the net benefits to irrigation reservations at all three levels of new irrigation are negative, ranging from minus $188.6 million for the Consumptive alternative, minus $27.2 million for the Combination and minus $2.8 million for the instream (Table S-2 in Exhibit 13). In other words, the benefits of the irrigation use of these consumptive withdrawals on aggregate are outweighed by the costs of foregone recreation and hydropower instream uses. This indicates that the irrigation reservations are not in the public interest on this

particular benefit-cost test.

Q. Does this suggest that given the symmetry of an evaluation from the standpoint of irrigation or instream flows, as you noted earlier, that the competing instream reservations are in the public interest based on the DNRC study?

A. Yes. As shown specifically in Part A(3) of Exhibit 4, when the "without instream flow reservation" reference point for instream flow valuation is the full irrigation reservation (eg. 212,209 acres of new irrigation), the net benefits of the instream reservation are plus $188.6 million (symmetric to the negative benefits of the Consumptive irrigation alternative in Table S-2).

Q. Would you conclude that DNRC's estimate of $188.6 million represents the net benefits of DFWP's reservations.

A. No, one needs to look at the individual project level findings. It turns out there are some inconsistencies between DNRC's aggregate and project level results and some accounting errors in the analysis. As noted these are listed in Exhibit 11 and need to be examined in detail. I think it's worth going through these in order to develop a correct record.

Q. The first issue you list in Exhibit 11 is "arithmetic"; what is this problem?

A. As you will note in Table S-1 (Exhibit 13) there is an error in addition for the "combination" alternative; there is also a typographical error for irrigation benefits which should be $111.9 million based on Table S-2 and earlier tables. In the text on page S-7, DNRC concludes that the "Net benefits per year are greatest under the Combination Alternative.." (also in Exhibit 13). This is not true and is merely the result of the arithmetic error. The highest benefits are under the Instream Alternative given their analysis.

Q. Are there other problems with the summary conclusions provided?

A. Yes. Also in Exhibit 13 and on page S-7, it is noted that "Sixty-two proposed irrigation projects would value an acre-foot of water at a greater level than the instream values..". This seems strange (though it is possible) that so many projects would pass a benefit-cost test but the aggregate results for irrigation would all show negative net benefits (eg. Table S-2). On closer inspection, it turns out that the project level analysis (Appendix K) is a hybrid of a feasibility analysis and a benefit-cost analysis. Specifically, replacement cost of power was not incorporated

at the project level benefit-cost, but was at the aggregate level as a line item in Table S-1. This is the second problem listed in Exhibit 11 and leads to an overstatement of which projects pass a benefit-cost test.

Q. What is the third problem?

A. Throughout the EIS, DNRC references a range of values for hydropower, for example on pages 232-233 the range of 50 to 100 mills is consistently noted and in fact total social costs of hydropower losses and replacement power costs are listed on page 233 as being $253.4 to $669.8 million. But in Table S-1, only the lower range is used and no mention of sensitivity to the upper range is discussed. This is misleading. In any case, even the analysis as it stands shows the instream alternative as superior, but this finding would be much clearer if both ends of the plausible power cost range were shown.

Q. Does DNRC specifically examine a complete instream alternative?

A. No. Only the specific combinations of alternatives are shown. In any case, given the problems with the project level analysis (no replacement cost of power, problem 2), the wrong "efficient" level would be identified. Similarly, instream benefits are never identified in a positive sense as would result from a statement of all competing uses in a consistent "with" and "without" framework. Accordingly, the "net benefits" to the instream alternative in Table S-1 are identified as $338.5 million. But the positive net benefits of the municipal allocation alone are $341. DNRC would need to separate the pass and not pass cases as was done in Exhibit 6 to identify the total net benefits acheivable for this allocation.

Q. Did DNRC consistently treat the cummulative effects of withdrawals on hydropower and recreation in downstream segments?

A. No. This was done correctly for hydropower (see Table K-2 and discussion in Exhibit 15) but not for recreation (contrast Table K-1, Exhibit 15 and the hydropower values in Exhibit 4). This understates recreation losses.

Q. Were irrigation return flows handled consistently?

A. No. The hydropower losses computed in the project level analysis are based on 50% return flows. But the aggregate losses shown in Table S-1 assume no return flows. The recreation losses shown in Table S-1 were apparently not built up from the Appendix K estimates but are derived from

Tables 6-40, 6-41, and 6-42 (Exhibit 18). For example, the annual loss shown in Table 6-42 if turned into a present value using the amortization factor apparently used in the irrigation analysis (.045229) yields a recreation loss of $70 million as in Table S-1, but only on the assumption of zero return flows. Accordingly, there are offsetting errors affecting the recreation values in Tables S-1 and S-2.

Q. Was the return flow assumption used consistent with DNRC's modeling of water availability?

A. It appears that the fairly sophisticated DNRC water modeling effort was never incorporated into the economic analysis of individual projects. This was discussed earlier. It appears that the assumption actually used in Appendix K (50% return flows) overstates return flows considerably for sprinkler irrigation (21% is more likely) and for some sprinkler irrigation there are no return flows likely for a number of years. This leads to an understatement of hydropower and recreation losses and an overstatement of irrigation net benefits.

Q. Were unquantifiable effects noted in the public interest criteria summary?

A. No. The influences of water quality considerations and fish and wildlife were not explicitly noted in the interpretation of the benefit-costs results of Table S-1 and S-2. However, these issues were addressed in detail earlier in the EIS Summary.

Q. Have you computed a corrected project level estimate of benefits and costs that corresponds to DNRC's basic assumptions?

A. Yes. The results are provided in Exhibit 14 and can be compared with the Table S-1 and S-2 results. Basically this run was done using our computer model and data base of Exhibits 8 and 9, but assuming 50 mill power and 50% return flows for all cases. We did correct to make the aggregation of hydropower and recreation take account of losses in downstream segments. We also included the costs of replacement power in the net benefit calculation.

Q. What were your findings?

A. We found that 47 cases would pass under DNRC's assumptions, as compared to the 62 they identified. The costs of the municipal reservations appear to have been greatly understated by DNRC ($1.9 million versus our $73 million, Exhibit 14). Perhaps DNRC's estimate is an annual rather than a present value. DNRC also appears to have scaled down

some of the municipal reservations. In our computation the net loss to irrigation under DNRC's assumptions is not as large, $119 million vs. $189 in Table S-2. For the efficient case, the net benefits of municipal are $379.6 plus the benefits of the irrigation projects that pass ($50.1 million) plus the benefits of instream flow realized by not passing the other 173 projects of $169 million.

Q. Do the scenarios discussed in Exhibit 14 provide a good basis for deciding which reservations to approve?

A. No. One would certainly want to use more realistic return flow assumptions as well as investigate the sensitivity to higher replacement power costs as in Exhibit 6. We feel that Exhibit 6 provides a good basis for deciding which reservations to approve. The findings in Exhibit 6 are of course summarized in Exhibit 33. The purpose of Exhibit 14 is to indicate the relationship of our analysis to the extensive work undertaken by DNRC.

PART VI. ANALYSIS OF SPECIFIC PROJECTS

Q. Can you indicate the significance of the key issues you raise in Exhibit 11 for some specific projects?

A. Yes. In Exhibit 17, I have shown the results of different assumptions concerning power costs, replacement power and return flows on two projects, GA-46 and GA-201.

Q. How did you choose which projects to examine?

A. Project GA-46 happens to be the first project on the list in Appendix Table K-4 (Exhibit 16). Project GA-201 is interesting because in the DNRC analysis it is the project with the largest gross irrigation benefits ($398.49 per acre-foot, Exhibit 16 and 17).

Q. What is the effect of correcting for water consumed in these projects?

A. In both cases (see part I of Exhibit 17) correcting for water consumed reduces gross benefits by about half. For example, in project GA-201, original gross is $398/AF consumed, but this assumes 50% return flows. With no return flows, which is apparently appropriate for this case given its location (discussion with Larry Cawlfield), gross benefits are $199.24. However, John Goroski of DNRC has been reexamining the earlier economic work on these projects and has concluded that the actual acre-feet required by the project (and consumed or lost) is 14508 acre-feet (not the 12249 originally requested). This leads to gross benefits of $168/AF. Project GA-201 is also one which would be

increasing arsenic concentrations in groundwater and is very susceptable to changes in electric power costs. The plan is to pump Madison River water about 37 miles in a pipeline up to 60 inch diameter to irrigate 7,980 acres. The pump requirements for the project are 15,335 brake horsepower, accordingly the power useage estimated is quite large, on the order of 15,912 GWhrs per year. The project expects to use Pick-Sloan power with a transmission line from Townsend so that power costs would be heavily subsidized relative to replacement power costs.

Q. What is the effect of correcting for replacement power costs?

A. This is in Part II of Exhibit 17. For GA-201 replacement power costs of 50 mills to 100 mills drop project benefits to $157 and $102 per acre-foot respectively. Given GA-201's large energy consumption of 15,912 GWhrs per year, the annual energy cost at 75 mills is $1.1 million.

Q. What about recreation and hydropower costs?

A. With these costs included, GA-201 drops to $37.72 for 50 mill power or to minus $86.28 per acre-foot for 100 mill power. The corrected net benefits for the GA-201 project at 50 mill of $37.72 compares to the $311.96 net benefits shown in DNRC's project level analysis in Appendix K (Exhibit 16). Similarly, as shown in Exhibit 17 in section III., the final corrected net benefits for GA-46 at 50 mill power is minus $67.52 compared to DNRC's positive net benefit estimate in Appendix K (Exhibit 16) of $44.62.

Q. What do these project level computations show?

A. If someone wants to understand the significance of replacement power costs and return flows for project economics, I think Exhibit 17 provides some interesting examples. It also demonstrates why DNRC's project level analysis is somewhat inconsistent with the aggregate results reported. The specific inconsistencies were shown in Exhibit 11.

Q. What do you conclude regarding the use of DNRC's summary findings on public interest in Tables S-1 and S-2 and the text on page S-7?

A. For the reasons outlined here, I think the analysis presented in Exhibit 6 provides a more accurate picture. In fact Exhibit 6 only builds on the considerable work done by DNRC. It should be noted that the kind of errors that are detailed in Exhibit 11 and that invalidate the specific findings of Tables S-1 and S-2 are also the kind of mistakes

that can be easily corrected. Our corrections entailed changes in few lines of computer code and the addition of a variable or two to the data file. I presume that DNRC's Final EIS will incorporate some of these changes.

PART VII. ANALYSIS OF RECREATION BENEFITS

Q. What will you address in this section of your testimony?

A. I will discuss the basis for our estimated benefits associated with recreational use of the waters in the Upper Missouri Basin.

Q. How is this section organized?

A. First I will describe the general methods for valuing recreational experiences and the application of these methods to Missouri Basin streams to develop estimated net benefits per recreational day. These estimates, along with estimates of total recreational use result in estimated baseline recreational values, such as those mentioned in DFWP's reservation application date June 1989. Finally, I will discuss methods for measuring the change in baseline recreation benefits as instream flow levels change. This results in the dollar values per acre-foot that were used earlier in my testimony (Part III and IV) to value the application of instream water to the recreational beneficial use.

Q. How do you measure the net benefits of recreational use?

A. The net economic benefits of a recreational activity, such as fishing, are measured by the recreator's willingness to pay for the right to participate in this activity over and above the recreator's cost of participation. For example, it was found in a 1985 survey of licensed Montana anglers (Duffield, Loomis and Brooks, 1987 in DFWP Exhibit 7) that nonresident anglers spent an average of $536 per trip for trips to Montana for the primary purpose of fishing. These costs include gas, food, lodging and equipment and are just as important to the economy as dollars spent in other activities such as irrigated agriculture. Once the recreator is at the site, for example at the Madison or the Big Hole River, these individuals would generally be willing to pay, if they had to, an additional amount for the right to fish.

Q. How do you know this?

A. There are many examples where people pay fees for access to recreational fishing opportunities. In European countries such as Norway it is not uncommon for fishing rights to go with ownership of the adjacent land. In 1983 I spent 8

months in Norway and found prices ranging from as low as $15 per day to upwards of $200 per day for the right to fish on rivers for Atlantic Salmon. These prices basically varied with the quality of the fishery. Here in Montana there are only a few fee fisheries such as Nelson Spring Creek where recently the summer price was $40 and the winter price per day of fishing per person was $20. A recent price on the Red Rock River was $45.

Q. Isn't the economic value of fishing measured in the value of a fish, that is in dollars per pound?

A. No. This is a common point of confusion that arises because people do not make the distinction between commercial and recreational fishing. In commercial fishing, workers are paid to fish and the net value of this productive economic activity is the value of the product, fish, times price, less the economic costs of the activity. This is the same way we conceptually value the output of other productive activities such as irrigated agriculture in my earlier testimony in Part VI.

Q. How is recreational fishing different from commercial fishing?

A. In recreational fishing the "product" is the recreational experience, not the fish. In fact, on many of our streams and in particular for many of the most dedicated anglers, no fish are even kept. It is primarily catch and release fishing. It is obviously misleading to try to apply a commercial value per pound approach in these situations.

Q. What are the primary methods for estimating the economic value of outdoor recreation?

A. Where markets exist for recreational use at a given site, such as fee fishing or fee hunting, the historical relationship of price to use can be used to estimate willingness to pay.

Q. Why can't one just use the market price in these cases?

A. Market prices for unique resources only measure the willingness to pay for the marginal user - the one who is ambivalent about the visit and, if prices increased slightly, would discontinue use. There may be many other "inframarginal" users who would pay considerably more than the price before discontinuing use. The theoretically correct approach is to estimate the total willingness to pay across all users. Net benefits are then total willingness to pay less costs associated with operation or provision of the site.

Q. How does one measure this total willingness to pay?

A. There are two general cases, depending on whether or not markets exist for the given resource. Where markets exist, one estimates an economic demand function (relating price and quantity) and takes the area under this curve out to the current price and quantity demanded.

Q. Is it also necessary to estimate an economic demand curve for the value of other services or products that may be relevant in these proceedings like electricity or alfalfa hay?

A. Not necessarily. For agricultural products such as alfalfa hay where the market is fairly competitive, the demand function faced by any given producer is what economists call "highly elastic". This simply means that the price is constant across the foreseeable quantitites a given producer can supply. This is in part because the output of any given producer is quite small relative to the total market for this product. In this case, changes in total value are well-approximated by simply price times quantity.

Q. Has this convention been used in the analysis by DNRC of the benefits and costs of the irrigation use?

A. Yes, the incremental agricultural production is valued at average crop price. The use of market prices is appropriate for this case.

Q. Do the prices you mentioned earlier, for example on Nelson Spring Creek and the Red Rock River, represent average willingness to pay on these streams?

A. No. Some individuals may be willing to pay more than these prices. Additionally, since these are fee sites surrounded by many open access public fisheries, the price may be more representative of the quality differential (perhaps related to lower congestion) between the fee site and public sites, rather than a measure of the value of the experience at the given site.

Q. How does one measure willingness to pay if markets do not exist for the resource?

A. In this case, one uses nonmarket valuation methods.

Q. What are the nonmarket valuation methods for outdoor recreation?

A. There are two basic methods that are widely accepted: the travel cost method (TCM) and the contingent valuation method

(CVM).

Q. Have these methods been previously used to value recreational use in instream flow valuation proceedings in Montana?

A. No. However, in 1977 Richard Stroup, an economist at Montana State University, provided testimony on the recreational values associated with the proposed Yellowstone River reservation. He concluded "I believe these values would be substantial ...and should not be ignored in any allocation of water rights." However, Stroup also noted that "reasonable estimates on recreator's valuations" were not at that time available (Exhibit No. DFG-1781r-15 in the Yellowstone reservation proceedings).

Q. Why weren't values available at that time?

A. At the time Stroup was writing, 1977, nonmarket valuation studies of outdoor recreation activities were just beginning to be widely applied. A good index to the growth of research activity in this field is provided by the review undertaken by the U.S. Forest Service every five years for is Resource Planning Act estimates of recreation values. This information is tabulated in Exhibit 19. As of 1978, only 15 studies had been completed in the United States and only 5 of these were on trout fishing. By 1988, there were 120 such completed studies and 40 studies of trout fishing, including work in Montana.

Q. What is the travel cost method?

A. The travel cost approach uses observations of trip distance and costs as a measure of price, and observed trips per capita taken as a measure of quantity, to statistically identify a site economic demand function. For example, one might look at how many trips are taken to the Madison River from various origins such as Missoula, Butte, and Helena. The plot of such a relationship based on actual data for the Madison River is shown in Exhibit 20. Not surprisingly, higher the travel cost (and distance) from the Madison River leads to lower trips per capita. Based on the assumption that recreationists would react to a site fee in the same way as the observed response to higher travel costs, the analyst can estimate the additional amount recreationists would pay for use of the site over and above their actual travel costs.

Q. What is the contingent valuation method?

A. In the CVM approach, individuals are directly surveyed as to their willingness to pay for the services of a given resource contingent on their acceptance of a hypothetical

market situation. For example, visitors to the Madison River may be asked to suppose that they might have to drive an additional distance or pay additional travel costs to continue to use the site. Under this hypothetical situation, they are asked how much they might be willing to pay before choosing not to visit the site. Actual data for responses to a survey concerning fishing trips to the Madison River is shown in Exhibit 21. Respondents were asked, "would you still have made this trip if your expenses had been __ (dollar amount) __ more?". The higher the dollar amount, the lower the probability of a "yes" response. This data is used to construct probability distributions of willingness to pay (Exhibit 22) and from this average or median willingness to pay can be derived. Exhibit 22 also provides data for the Missouri Holter-Cascade section. It may be noted that a lower percentage of individuals are willing to pay a given dollar amount on the Missouri compared to the Madison. This leads to lower estimated values for the Missouri as can be seen in Exhibit 23.

Q. What evidence is there that these are the accepted procedures for valuing recreation?

A. Federal benefit-cost guidelines require the use of these procedures in the evaluation of water development projects. Specifically, TCM and CVM are endorsed by the U.S. Water Resources Council for site-specific estimates of recreation values, as noted in the current standards I had previously mentioned, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (1983). More recently, TCM and CVM have been designated as among the "best available procedures" for estimating natural resource damages under the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). This is detailed in the Department of Interior regulations (43 C.F.R. § 11.10-11.93 (1987)) for evaluating damages in "superfund" cases. The latter were issued in August, 1986.

Q. Have these methods been accepted by the courts?

A. Yes. As a recent example, industry petitioners challenged Interior's endorsement of contingent valuation as a best available procedure in CERCLA-related natural resource damage assessments. The D.C. Court of Appeals emphatically rejected this challenge in its ruling issued July 14, 1989 (Ohio v. United States Dep't Interior, 880 F.2d 432 (D.C. Cir. 1989)).

Q. What general approach have you taken to developing baseline recreational values for waters in the Missouri River Basin?

A. Well-developed markets for recreational use of rivers do not exist in the Missouri River Basin. Accordingly, it is necessary to use nonmarket valuation methods. Both travel cost and contingent valuation methods are valid and accepted procedures and have been applied in this river basin.

Q. Can you briefly describe these studies and the main findings?

A. Yes. There are three different more or less basin-wide studies that have been undertaken for the analysis of recreation values in the Upper Missouri Basin. Two of the studies were part of the Montana Bioeconomics Project, which was an extensive series of TCM and CVM estimates of statewide hunting and fishing values undertaken by Montana DFWP in 1985-1988. One study is a TCM analysis of cold water fisheries statewide (Duffield, Loomis and Brooks 1987 in DFWP Exhibit 7) and the other is a CVM study of 17 of our better trout streams (see DFWP Exhibit 8). The data base for the TCM study compliments a longer series of statewide angler and hunter use (or "pressure") estimates also developed by Montana DFWP. The third basin-wide study was undertaken by Montana DNRC for purposes of evaluating the recreational value of instream flow reservations in these proceedings. This was a CVM study (Duffield, Neher, Patterson and Allen 1990 in DFWP Exhibit 9) of all river-related recreational use in the Upper Missouri Basin. It was based on a large sample (about 10,000 surveys mailed) using a Montana driver's license sample frame for residents. This was done in order to sample boaters and shoreline recreationists in addition to resident anglers. Nonresident anglers were sampled through Montana nonresident fishing licenses.

Q. What were the findings of these studies?

A. The main purpose of the Montana Bioeconomics Study was to estimate average willingness to pay for anglers and to use these values to estimate total value of the resource for fishing under current conditions. Estimated willingness to pay per trip for anglers is shown in Exhibit 23 for both the TCM and CVM models for most of the major trout streams in the state.

Q. Would you expect the TCM and CVM estimates to be identical?

A. No. Since the TCM is measuring the area under an ordinary demand curve, there are theoretical reasons for expecting the CVM estimate to be slightly smaller. This is because the CVM measures in this case what is termed "compensating variation" which is the area under an "income-compensated" demand curve. However, these differences are likely to be

small for goods like recreation. Accordingly, we expect TCM and CVM to be not exactly equal, but generally close.

Q. Are the TCM and CVM estimates in Exhibit 23 based on two totally different data bases and two very different methods of analysis?

A. Yes. The TCM estimates are based on observed behavior while the CVM requires response to hypothetical questions.

Q. Are the valuation estimates similar across sites?

A. Yes. I computed Pearson and Spearman correlation coefficients that measure the degree of correlation between the two measures. For example, if the TCM and CVM estimates were identical for every stream, the correlation coefficient would take a value of 1.0. If there was no similarity, it would take a value of zero.

Q. What values did you find?

A. For the seventeen river sample shown, the correlation from both measures is about .70; this is a highly significant correlation. When sites for which the CVM samples were less than 80 observations are excluded, the correlations are even higher with correlations around .80.

Q. What do you conclude from this?

A. The strong correlation shown by the Pearson coefficient indicates that the two methods result in estimates that are similar in magnitude for a given site. The Spearman coefficient indicates that the two methods provide a similar ranking of sites from most to least valuable.

Q. How do you interpret the increased correlation when sites with small CVM samples are excluded?

A. This is encouraging as to the consistency of the method because site estimates based on small samples are less precise. If the correlation is higher for the more precisely estimated values, this suggests that the underlying methods are sound and that the estimates could be improved by using larger sample sizes.

Q. Have other studies also found some agreement between TCM and CVM estimates?

A. Yes. For example this is a finding of an extensive review of outdoor recreation valuation commissioned by the U.S. Forest Service in 1988 as previously noted in Exhibit 19. There have been quite a number of such comparisons which tends to

validate the methods.

Q. Are there other approaches to validating the use of these nonmarket methods?

A. Yes. One approach is to set up cash transaction experiments where people actually have to pay money for the resource in question. These are done in a side by side comparison with either TCM or CVM or both.

Q. What is the general finding of this research.

A. The general finding is that there is fair consistency between the fee experiments or "simulated market" values and both TCM and CVM, particularly for willingness to pay measures. For example, Richard Bishop at the University of Wisconsin has conducted a number of such studies on goose hunting and deer hunting permits.

Q. Are there other approaches to validating these methods?

A. Yes. It is possible to also compare values derived from related markets.

Q. What is the finding of these types of comparisons?

A. These also tend to support the method. For example, I have estimated net willingness to pay for elk hunting from the response to changes in nonresident license fees, which have increased from under $100 to $450 for a season combination license in the last decade. The values derived from the bona fide economic demand for nonresident hunting licenses are quite similar to values based on both TCM and CVM studies of elk hunting in Montana.

Q. What do you generally conclude concerning the validity of the recreation value estimates you have presented in Exhibit 23.

A. I think there is considerable evidence that these are valid estimates, based both on the comparison across methods specific to Montana streams and on the more general validation of the methods found in the economics literature.

Q. Were the values you report in Exhibit 23 used to develop baseline recreational value estimates for the DFWP Missouri River instream flow reservation application?

A. Yes. In the June 1989 DFWP application Volume 1, p. 1-46, an estimate is derived of the total fishing related recreational value in Missouri River basin streams and tributaries above Canyon Ferry. The total estimate for 1985

is $50,962,000. This estimate is based on the TCM values from Duffield, Loomis and Brooks 1987 (DFWP Exhibit 7), some of which are displayed in Exhibit 23. These values are based on angler reported costs per mile of travel.

Q. What are the findings of the recreational value study undertaken by DNRC for purposes of evaluating the DFWP instream flow reservations in this proceedings?

A. The estimated values per trip and per day for river-related recreation in the Upper Missouri Basin for 1989 for the study supported by DNRC (DFWP Exhibit 9) are shown in Exhibit 25 on a sub-basin, residency and water-type basis. The values are similar to those in Exhibit 26. A total baseline value estimate for all river-related recreation is shown in Exhibit Rec-8. Additionally, estimated total days of use, recreation expenditures per day and total expenditures are also shown in these exhibits.

Q. Is the estimated total baseline recreational value from the DNRC study consistent with the $50 million estimate in DFWP's application?

A. Yes. However, the DFWP estimate is just for anglers (which represent only about 42% of all resident river-related use) and just for the part of the basin above Canyon Ferry where about 60% of recreation in the basin takes place. DNRC estimated total net economic value of river-related recreational trips in the basin at $110 to $175 million. Based on the statistical methods used and as discussed in detail in Duffield, Neher, Patterson and Allen (DFWP Exhibit 9), one can be 95% sure that the true value is within this range. The share of this total that is due to just fishing in the basin above Canyon Ferry is $40 to $97 million. The estimate in DFWP's application based on the earlier TCM study is within this range and is therefore consistent.

Q. What is the implication of these total baseline values in the basin of $110 to $175 million for your previous analysis of DFWP's 232 reservations for which there are no competing uses?

A. Recall that in Exhibit 10 I used a baseline value of $62 million which includes just angler use. This is similar to the estimate of $50 million in DFWP's application of June 1989, but includes a few more of the cold water fisheries in the basin. The $62 million baseline is quite conservative because it excludes nonangler use and therefore the estimated value of the reservations derived in Exhibit 10 may also be conservative.

Q. Have you investigated the precision of these recreation

value estimates?

A. Yes. Standard errors for the Duffield, Neher, Patterson and Allen (DFWP Exhibit 9) estimates are provided in Exhibit 25.

Q. What do standard errors tell us?

A. Standard errors are a statistic associated with a given point estimate that can be used to define the range or interval that more than likely contains the "true" point estimate. As noted, for the baseline recreation value estimates in Exhibit 25, for example, we can be 95 percent sure that the "true recreational value" is within plus or minus 1.96 (or about two) times the standard error. This range is referred to as the "95 percent confidence interval".

Q. How did you compute standard errors for your recreational value estimates?

A. It is impossible to derive analytical standard errors for a measure like the CVM truncated mean (which requires numerical methods). Accordingly, in both cases we used a statistical procedure called "bootstrapping" which involves repeated draws (200 iterations were used in this case) from the statistical distributions appropriate for each case. This is very computationally intensive (requires a lot of computer time), but is a well-accepted procedure.

Q. How are instream flow levels likely to influence the total recreational values derived from river-related recreation in the Upper Missouri River Basin?

A. The general types of impact that reduced streamflow, for example from drought, can have on river-related recreation is shown generally in Exhibit 27. Streamflows can directly affect the numbers of recreationists, the quality of the experience for recreationists that continue to use the stream, and it can also affect fish stocks which can impact the quality of present and future recreational use. The latter type of relationship is generally supported by the discussion of the wetted-perimiter and biological-flow relationships described in DFWP's June 1989 application.

Q. Have you analyzed any of these possible types of impacts of reduced streamflow on recreation?

A. Yes. For purposes of the study undertaken in 1989 for DNRC, we examined the relationship of flow to recreational participation. One would expect that if use was examined over a full annual hydrological cycle there would be a relationship like that shown in Exhibit 28. With no water,

there is clearly no river-related recreation of the boating and fishing variety. As streamflows increase there is an optimum level of flows that may vary with the type of recreation, for example, white water kayaking on the Gallatin versus fishing on the Gallatin. At very high flow levels, eg. flood, most types of recreation become impossibly dangerous.

Q. Is this general relationship supported by any evidence?

A. Yes. For example the profile of average recreational use per week on the Smith River is shown for the years 1984, 1986 and 1987 in Exhibit 29. The river is at high flow levels early in the float season and declines to levels that make boating impossible later in the summer. Use reflects these flow patterns, peaking in late June and declining toward the end of the summer. The low use level in early June may be as much a function of the weather. Exhibit 30 provides an illustration of the relationship of use over the season for the Smith versus days in the float season for a given year. In years when the float season is short due to low flows, use is also lower.

Q. Do low stream flows affect river-based outfitter businesses in Montana?

A. Yes. In a survey of Montana river outfitters, 57% reported that the droughts of 1988 and 1989 resulted in decreased number of trips taken with their businesses (DNRC Draft EIS, p. 110).

Q. How did you quantitatively relate changes in streamflow levels to changes in recreational values for you 1990 study for DNRC?

A. We used a method developed by Narayanan (see DFWP Exhibit 9). Recreationists are asked at what hypothetical flow level (as a percent of the flow experienced on a recent trip) they would discontinue visiting the given river. A relationship of the type shown in "Figure 3" in Exhibit 31 is estimated and used to predict the percent change in visitation that will result from a given percent change in flow. This model, plus a baseline recreational value estimate, can be used to compute marginal recreational values per acre-foot of stream flow.

Q. How do marginal values change with respect to streamflow?

A. As illustrated in "Figure 4" in Exhibit 31, for small changes from the actual experienced (or 100%) flow levels, the effect on recreation values is small. At some threshold, for example where boating becomes impossible, values are at

their maximum. For our estimated model, this is usually around 60%-80% of the flow levels experienced in 1989. Values decline continuously below that level, so that once the stream is essentially empty, small changes have little effect on visitation and values.

Q. What are the specific dollar per acre-foot values from your model for the Upper Missouri?

A. These are shown in "Table 44" in Exhibit 32. These values vary considerably depending on time of year, the river location and the relative level of flow. The range is from $68 per acre-foot in the Upper Subbasin in July-August and for changes around a 75% threshold, to only $2 for the Lower Subbasin for small changes around 100% flows and for September-June. The dollar values largely reflect the amount of recreational use on a given stream and the fact that most recreational use is in the summer.

Q. Which of these values were used in the computations previously described in your summary of findings, Part III and Part IV of this testimony?

A. DNRC's study used the values reported in Table 6-40 in the Draft EIS and reproduced in Exhibit 32. These values are for the 100% flow levels. This is appropriate for the case at hand. It may be noted that the 100% values are considerably below those at lower reference flow levels.

Q. Is there another way to get dollars per acre-foot for recreational use values?

A. Another way to do it would be to not use Narayanan's model and just simplify the entire procedure by using average values. In this case one just divides baseline recreational values by the average flow. These values are shown in the Duffield, Neher, Patterson and Allen 1990 study (DFWP Exhibit 9) in Table 46, page 43. For example, the average recreational value per acre-foot in the Upper Subbasin in July-August is $47.94 compared to the 100%-marginal value DNRC actually used of $35.40. Not surprisingly, the average values are all higher than the marginal values at 100% flows.

Q. How did DNRC compute the aggregate estimate of $70 million for lost recreational use value associated with the Consumptive Use option in the Summary Table S-1 (Exhibit 13) as previously discussed?

A. This is shown in DNRC Tables 6-41 and 6-42 from the Draft EIS and as reproduced in Exhibit 32. DNRC estimated the total change in acre-feet by time of year and subbasin, then

multiplied that by the previously mentioned values per acre-foot. The result for the consumptive use case is $3,198,000 per year lost recreational value. The present net worth of this annual loss over 70 years and at 4.3% discount rate is $70 million. This was also previously noted with regard to Exhibit 18.

Q. Are there other studies that have estimated the recreational value per acre-foot of instream flows in Montana?

A. Yes. In addition to the study previously described using Narayanan's method, I have participated in two other instream flow valuation studies using very different methods. One of these used a pooled time series-cross sectional TCM model for 19 Montana rivers for 1982, 1983 and 1985. I also undertook a study that used on-site surveys of the Big Hole and Bitterroot Rivers. Observed visitation and willingness to pay per trip were estimated as functions of actual observed daily dischage levels measured at U.S. Geological Survey stations. The estimated value per acre-foot of all three studies are compared for the Big Hole River as discussed in DFWP Exhibit 9, pages 43-45.

Q. What was your conclusion in this comparison?

A. The finding was that there was remarkable similarity in estimated values per acre-foot for this river across all three methods. This provides a measure of validation for the estimates used in the DNRC Draft EIS.

PART VIII. SUMMARY AND CONCLUSIONS

Q. How would you summarize your findings with regard to which of the water reservations at issue in this proceeding are in the public interest, on a narrow benefit-cost criteria?

A. I have summarized my findings in Exhibit 33. I would conclude that 100% of the 21 municipal reservation requests are in the public interest with net benefits over 70 years (present value at 4.3% interest) of $380 million. For the conservation district requests, only 3% or 2 of the 220 reservation requests have project benefits in excess of direct and indirect costs. These projects are particularly costly in terms of foregone hydroelectric power generation, which I would suggest be valued at a replacement cost of 75 mills per kilowatt hour. For DFWP's instream flow reservation requests for which there are competing consumptive uses, I found that an allocation of 89.3% of the reservation requests (47 DFWP reservations affected) were in the public interest with net benefits of $604 million. For DFWP's reservation requests with no competing uses, of which there were 232, 100% of the reservations are in the public

interest with net benefits of $697 million.

Q. What are the total net benefits of the water allocation you recommend?

A. As shown in Exhibit 33, the total net benefits to the DFWP reservations is on the order of $1,302 million. Municipal benefits are $380 million and conservation district benefits are $17 million for a total of $1,698 million total net benefits.

Q. Are there important unquantified benefits?

A. Yes. These have to do with water quality and fish and wildlife uses. The presence of these significant beneficial uses strengthens the case for the recommended instream flow reservations.

Q. Does this complete your testimony?

A. Yes, it does.

I, John Duffield, being first duly sworn, state that the foregoing testimony is true.

Dated this ____ day of October, 1991.

____

John Duffield

Subscribed and sworn to before me this 30 day of October, 1991.

Notary Public for the State of Montana

Residing at Missoula, Montana.

My commission expires 7-5-94.

EXHIBIT 1

DEFINITION AND BOARD DECISION CRITERIA FOR MONTANA WATER RESERVATION APPLICATION, BASED ON ADMINISTRATIVE RULES OF MONTANA (12/31/88).

(A) 36.16.102 DEFINITION

(3) "Beneficial use" means a use of water for the benefit of the appropriator, other persons, or the public, including but not limited to agricultural (including stock water), domestic, fish and wildlife,industrial, irrigation, mining, municipal, power, and recreational uses. For the purpose of these rules, the term beneficial use includes the maintenance of a minimum flow, level, or quality of water.

(6) "Direct benefits" mean all benefits to the reservant derived from applying reserved water to the use for which it is granted.

(7) Direct costs" mean all costs to the reservant resulting from applying reserved water to beneficial use for the purpose granted.

(12) "Indirect benefits" mean the benefits of applying reserved water to beneficial use that accrue to other uses or to parties other than the reservant.

(13) "Indirect costs" mean the benefits of applying reserved water to beneficial use that accrue to other uses or to parties other than the reservant.

(17) "Net benefits" mean indirect and direct benefits less indirect and direct costs.

(B) 36.16.105C APPLICATION CONTENT -PUBLIC INTEREST

(a) An analysis of the direct benefits and costs associated with applying reserved water to the proposed beneficial use.

(b) A discussion of the indirect benefits and costs associated with applying water to beneficial use that considers the following:
(i) effects on future economic activity;
(ii) effects on the environment;
(iii) effects on public health and safety; and
(iv) the economic opportunity costs that the requested flow may have to parties other than the reservant.

(Exhibit 1. Continued)

(C) 36.16.107B BOARD DECISION CRITERIA - PUBLIC INTEREST

(4) For the board to adopt an order reserving water, it must find, in its judgment and discretion, that the reservation is in the public interest, as required in 85-2-316 (4)(a)(iv), MCA, based on a weighing and balancing of the following factors, after making a specific finding for each factor:

(a) whether the expected benefits of applying the reserved water to beneficial use are reasonably likely to exceed the costs where:
(i) benefits include all direct and indirect benefits where any non-market benefits are quantified and valued to the extent reasonably possible;
(ii) costs include all direct and indirect costs where any non-market costs are quantified and valued to the extent reasonably possible; and

(b) whether the net benefits associated with granting a reservation exceed the net benefits of not granting the reservation;

(c) whether there are no reasonable alternatives to the proposed reservation that have greater net benefits;

(d) whether failure to reserve the water will or is likely to result in an irretrievable loss of a natural resource or an irretrievable loss of a resource development opportunity;

(e) whether there are no significant adverse impacts to public health, welfare, and safety; and

(f) any other factors the board finds relevant, based on the record.

EXHIBIT 2

Outline of Direct Testimony - John Duffield

I. Purpose of Testimony

II. Board Decision Criteria

III. Values per Acre-foot

IV. Summary of Findings - Public Interest Criteria

V. Comparison to DNRC Draft EIS Summary

VI. Analysis of Individual Projects

VII. Analysis of Recreation Benefits

VIII. Summary and Conclusions

EXHIBIT 3

MONTANA WATER RESERVATION APPLICATION; COMPONENTS AND BENEFITS AND COSTS BY TYPE OF RESERVATION.

(A) Montana Department of Fish, Wildlife, and Parks Instream Flow Reservation Request.

ITEM	RELEVANT BENEFICIAL USE[1]
Direct Benefits	Fish and wildlife Recreational
Indirect Benefit[2]	Hydropower Water Quality[3]
Direct Costs	DFWP Fishery/Recreation Programs
Indirect Costs	Foregone consumptive view: Municipal Irrigation

(B) Montana Conservation Disticts Irrigation Reservation. Applications.

Direct Benefits:	Irrigation
Direct Costs:	Irrigation System Capital, Operation, Maintenance and Energy Costs
Indirect Costs:	Foregone instream uses: Fish and wildlife Recreational Hydropower Water quality

(C) Municipal reservations. Symmetric to irrigation case.

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[1] These are legal, personsal, and beneficial uses based on the Administrative Rules of Montana (12/31/88 36.16.102(3)

[2] May also include channel stability per Bureau of Land Management reservation request.

[3] Includes, for example, Montana Department of Health and Invironmental Services request for dilution flows for arsenic.

Exhibit 4. Values per acre-foot.

Item	(Dollars/AF)		
(A) Hydropower values per acre foot.			
	Replacement power cost		
	50 mills[1]	75 mills	100 mills
Headwaters	69.16	103.74	138.32
Upper Missouri			
Above Canyon Ferry	65.16	97.74	130.32
Below Canyon Ferry	59.07	88.61	118.14
Marias/Teton	30.38	45.57	60.76
Middle Missouri	30.38	45,57	60.76
(B) Recreation[2]	July & Aug	Rest of Yr	Average[3]
Headwaters	60.67	14.62	50.37
Upper Missouri	25.27	6.39	11.73
Marias/Teton	5.81	1.63	4.33
Middle Missouri	5.81	1.63	4.07
(C) Summary of instream values for 75 mill power			
	Hydropower + Recreation average		
Headwaters		154.11	
Upper Missouri			
Above Canyon Ferry		109.47	
Below Canyon Ferry		100.34	
Marias/Teton		49.90	
Middle Missouri		49.64	

Exhibit 4 continued.

Item	(Dollars/AF)	
(D) Irrigation (all projects)		
(a) Gross benefits of DNRC; 40 mill power,50% return flows	41.68	-27.39 - 398.49
(b) Gross benefits return flows at 21% for most sprinklers, 0% for some sprinklers, 43% for flood, actual use for GA-201, GA-46	25.55	-13.69 - 168.22
Net benefits		
(1) 50 mill power	-38.36	-105.23 - 99.22
(2) 75 mill power	-68.67	-147.13 - 78.69
(3) 100 mill power	-98.98	-189.03 - 58.16

Exhibit 5. Sensitivity analysis of efficient allocation to return flow and replacement power cost assumptions.

(A) Number of irrigation projects which pass benefit cost test.

	Assumed return flow		Assumed social cost of power			
Scenario	Sprink.	Flood	Hydro	Replace	# Pass	# Fail
DNRC	50%	50%	50 mill	40 mill	60	160
(A)	50%	50%	50 mill	50 mill	47	173
(B)	21%[1]	43%	50 mill	50 mill	11	209
(C)	21%	43%	75 mill	75 mill	2	218
(D)	21%	43%	100 mill	100 mill	2	218

(B) Efficient allocation of water for different scenarios.

Scenario	Acre-feet to irrigation	Acre-feet to instream
DNRC	47,753	342,528
(A)	41,309	348,972
(B)	28,808	361,480
(C)	10,650	379,631
(D)	10,650	379,631

[1] For projects where it was known that no return flows were expected, 0% return was used in project evaluation.

Exhibit 6. Net benefits to municipal and irrigation reservations under alternative hydropower costs and alternative water allocations.

Item/Scenario	Water allocation		
	Consumptive	Efficient	
		Pass B/C	Not pass B/C
(A) Physical description of alternatives at 75 mill Hydropower			
Irrigation projects	220	2	218
Acres to new irrigation	212,209	2,236	209,973
Acre-feet of water to irrigation	390,281	10,650	379,631
Acre-feet to municipal	34,659	34,659	0
(B) Benefits and costs of municipal at 75 mill hydropower			
Benefits	452.12	452.12	
Costs			
Recreation	-8.94	-8.94	
Hydropower	-63.55	-63.55	
Net benefits	379.63	379.63	
(C) Benefits and costs of irrigation			
(1) At 50 mill hydropower (scenario B)			
Irrigation projects		11	209
Benefits	143.54	73.84	69.69
Costs			
Replacement Power	-34.76	-3.86	-30.90
Recreation	-103.76	-14.50	-88.54
Hydropower	-337.99	-24.04	-313.94
Fish and wildlife	--	--	--
Water quality	--	--	--
Net benefits	-322.25	31.44	-363.69

Exhibit 6 cont.

Item/Scenario	Water allocation		
	Consumptive	Efficient	
		Pass B/C	Not pass B/C
(2) At 75 mill hydropower (Scenario C)			
Irrigation Projects		2	218
Benefits	143.54	17.25	126.29
Costs			
Replacement power	-121.65	-0.94	-120.71
Recreation	-105.61	-0.59	-105.01
Hydropower	-511.96	-6.71	-505.26
Fish and wildlife	--	--	--
Water quality	--	--	--
	-595.68	9.01	-604.69
(3) At 100 mill hydropower (Scenario D)			
Irrigation projects		2	218
Benefits	143.54	17.25	126.29
Costs			
Replacement power	-208.54	-1.61	-206.93
Recreation	-103.04	-0.60	-102.44
Hydropower	-675.98	-8.94	-667.04
Fish and Wildlife	--	--	--
Water quality	--	--	--
Net benefits	-844.02	6.10	-850.12

EXHIBIT 7

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 SCENARIO C; WEIGHTED REC; RETURNS, .425-FLOOD .2125-SPRINK ;75 MILL POWER  2
                                        16:50 Wednesday, October 30, 1991

BS     CODE        VALUE     VALREC     VALHY    INSTREAM        NET     DIVERSN2

 1     BR101       28.05      50.37     97.74     148.11     -147.134    11515.00
 2     BR103       51.16      11.73     97.74     109.47      -89.096     5066.00
 3     BR104      -27.39      11.73     97.74     109.47     -135.251    22491.00
 4     BR106       45.17      11.73     97.74     109.47      -99.499      676.00
 5     BR107       39.11      11.73     97.74     109.47     -102.176      278.00
 6     BR108       50.21      11.73     97.74     109.47      -93.674      229.00
 7     BR109       20.32      11.73     97.74     109.47     -115.835      258.00
 8     BR11        53.74      11.73     97.74     109.47      -98.724      119.00
 9     BR110       35.40      11.73     97.74     109.47     -107.747      467.00
10     BR111        8.83      11.73     97.74     109.47     -121.041       80.00
11     BR12       -26.60      11.73     97.74     109.47     -138.859      159.00
12     BR14        35.87      11.73     97.74     109.47     -108.680      746.00
13     BR28        40.66      11.73     97.74     109.47     -102.215      249.00
14     BR29        13.46      11.73     97.74     109.47     -115.419       48.30
15     BR34        68.38      11.73     97.74     109.47      -74.996      391.39
16     BR35        29.25      11.73     97.74     109.47     -107.548      391.39
17     BR38        92.51      11.73     97.74     109.47      -59.665       85.84
18     BR40        62.60      11.73     97.74     109.47      -91.417      126.00
19     BR41        65.61      11.73     97.74     109.47      -91.098      506.00
20     BR42        59.26      11.73     97.74     109.47      -81.686       63.79
21     BR44        36.35      11.73     97.74     109.47     -108.133     1243.00
22     BR5         35.05      11.73     97.74     109.47     -106.667      362.00
23     BR50        50.39      11.73     97.74     109.47      -91.123      469.35
24     BR52        50.68      50.37     97.74     148.11     -129.487       63.00
25     BS31         2.92       4.07     45.57      49.64      -47.787       58.28
26     BS32        15.78       4.07     45.57      49.64      -60.865     1506.00
27     BSS2         0.46       4.07     45.57      49.64      -69.484    44608.00
28     BUREC       21.75       4.07     45.57      49.64         .            0.00
29     CH181        0.00        .         .          .           .           29.92
30     CH201       54.31       4.07     45.57      49.64      -22.485       77.00
31     CH21        71.26       4.07     45.57      49.64      -10.809      319.72
32     CH211       15.84       4.07     45.57      49.64      -39.590      300.82
33     CH371        2.22       4.07     45.57      49.64      -55.565       23.62
34     CH381        6.94       4.07     45.57      49.64      -59.828     1912.00
35     CH511       12.06       4.07     45.57      49.64      -67.763     1577.00
36     CH541        9.87       4.07     45.57      49.64      -43.377       29.14
37     CH551       67.84       4.07     45.57      49.64      -15.720       86.00
38     CH641      -10.09       4.07     45.57      49.64      -56.042       41.74
39     CHI10       37.14       4.07     45.57      49.64      -37.486      247.28
40     CHI21       45.98       4.07     45.57      49.64      -32.372      592.20
41     CHI22       40.50       4.07     45.57      49.64      -36.158      306.34
42     CHI30       50.58       4.07     45.57      49.64      -25.107      506.36
43     CHI40       48.69       4.07     45.57      49.64      -18.746      228.37
44     CHI51       39.50       4.07     45.57      49.64      -24.577      192.15
45     CHI52       15.21       4.07     45.57      49.64      -39.989      200.81
46     CHI53       53.98       4.07     45.57      49.64      -15.390      227.59
47     CHI61       41.74       4.07     45.57      49.64      -23.156      194.51
48     CHI72       41.74       4.07     45.57      49.64      -23.156       84.26
49     CHI74       38.39       4.07     45.57      49.64      -25.282       83.47
50     CHI80       46.37       4.07     45.57      49.64      -20.218       96.07
51     CHS1         0.60      11.73     45.57      57.30      -79.890     3117.00
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SCENARIO C; WEIGHTED REC; RETURNS, .425-FLOOD .2125-SPRINK ;75 MILL POWER   3
                                          16:50 Wednesday, October 30, 1991

OBS     CODE       VALUE    VALREC     VALHY    INSTREAM        NET    DIVERSN2

 52     CHS3       26.54      4.07    45.570      49.640    -42.769    19654.00
 53     CHS5       29.13      4.07    45.570      49.640    -62.582     9058.00
 54     CHS6       -4.62      4.07    45.570      49.640    -71.698    35814.00
 55     CS101      79.74     11.73    88.605     100.335    -55.522      239.40
 56     CS102      55.75     11.73    88.605     100.335    -75.607      146.47
 57     CS111      66.27     11.73    88.605     100.335    -68.940      629.21
 58     CS159      33.64     11.73    45.570      57.300    -43.363       89.77
 59     CS171      27.77     11.73    88.605     100.335    -92.302       55.13
 60     CS21        1.42     11.73    88.605     100.335    -99.434      110.25
 61     CS231       5.95     11.73    88.605     100.335   -105.226       20.47
 62     CS241      39.39     11.73    88.605     100.335    -85.092      149.62
 63     CS251      35.87     11.73    88.605     100.335    -93.291      245.00
 64     CS252      42.35     11.73    88.605     100.335    -82.665       60.64
 65     CS271      53.06     11.73    88.605     100.335    -76.582      105.52
 66     CS31       15.66     11.73    88.605     100.335    -99.056       74.02
 67     CS32        9.12     11.73    88.605     100.335   -103.682       68.51
 68     CS331      38.35     11.73    88.605     100.335    -84.844       44.89
 69     CS351      51.64     11.73    88.605     100.335    -76.824      290.59
 70     CS42       38.71     11.73    45.570      57.300    -26.967      254.72
 71     CS43       64.21     11.73    45.570      57.300    -28.219      471.71
 72     CS44       43.90     11.73    45.570      57.300    -29.445       65.36
 73     CS471      23.22     11.73    88.605     100.335    -99.136       99.22
 74     CS51        7.55     11.73    88.605     100.335   -104.155      139.39
 75     CS52       24.01     11.73    88.605     100.335    -96.167       70.87
 76     CS541      61.88     11.73    88.605     100.335    -69.909       54.34
 77     CS61       70.53     11.73    88.605     100.335    -60.462      128.36
 78     CS62       42.04     11.73    88.605     100.335    -81.610      111.04
 79     CS63       32.74     11.73    88.605     100.335    -81.966      101.59
 80     CS64       33.56     11.73    88.605     100.335    -88.655       78.75
 81     CS71       24.80     11.73    88.605     100.335    -99.361       33.07
 82     CSI101     75.63     11.73    88.605     100.335    -58.199      175.61
 83     CSI102     56.58     11.73    88.605     100.335    -73.506      134.66
 84     CSI103     68.14     11.73    88.605     100.335    -64.343      438.64
 85     CSI11      52.37     11.73    88.605     100.335    -76.803      226.01
 86     CSI111     44.55     11.73    88.605     100.335    -82.456      663.86
 87     CSI12      37.24     11.73    88.605     100.335    -85.143       86.62
 88     CSI120     20.78     11.73    88.605     100.335    -97.426      104.74
 89     CSI21      46.94     11.73    88.605     100.335    -80.946      123.64
 90     CSI22      53.24     11.73    88.605     100.335    -76.640      128.36
 91     CSI23      35.16     11.73    88.605     100.335    -88.443      113.40
 92     CSI31      36.67     11.73    88.605     100.335    -84.420       85.84
 93     CSI32      15.67     11.73    88.605     100.335   -105.633       67.72
 94     CSI33      21.51     11.73    88.605     100.335    -98.296      118.12
 95     CSI34      30.04     11.73    88.605     100.335    -90.071      129.15
 96     CSI35      44.55     11.73    88.605     100.335    -77.770      199.24
 97     CSI41      37.70     11.73    88.605     100.335    -86.143      141.75
 98     CSI51      55.90     11.73    88.605     100.335    -75.882      196.87
 99     CSI52      73.37     11.73    88.605     100.335    -59.892      551.25
100     CSI71      29.87     11.73    88.605     100.335    -95.964      155.92
101     CSI81      32.13     11.73    88.605     100.335    -89.560       75.60
102     CSI82      31.37     11.73    88.605     100.335    -88.233      107.89
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SCENARIO C; WEIGHTED REC; RETURNS, .425-FLOOD .2125-SPRINK ;75 MILL POWER  4
                                               16:50 Wednesday, October 30, 1991

OBS    CODE        VALUE    VALREC     VALHY    INSTREAM         NET    DIVERSN2

103    CSI83       46.67     11.73    88.605     100.335     -78.081       77.96
104    CSI91       29.90     11.73    88.605     100.335     -89.574      101.59
105    CSI92       26.98     11.73    88.605     100.335     -89.611       56.70
106    CSS200      -0.42     11.73    88.605     100.335    -126.927    11885.00
107    FE111        0.63      4.07    45.570      49.640     -49.240       19.69
108    FE141       64.49      4.07    45.570      49.640      -9.473      295.31
109    FE161       32.64      4.07    45.570      49.640     -33.574      205.54
110    FE401       38.86      4.07    45.570      49.640     -36.494       64.00
111    FE41         1.51      4.07    45.570      49.640     -68.118      103.00
112    FE42        -7.00      4.07    45.570      49.640     -54.082       34.65
113    FE431       42.63      4.07    45.570      49.640     -33.619       84.26
114    FE561        0.00      4.07    45.570      49.640     -67.660      382.00
115    FE671       49.12      4.07    45.570      49.640     -32.328      589.05
116    FE672       61.81      4.07    45.570      49.640     -18.296      349.65
117    FE673       51.60      4.07    45.570      49.640     -25.090      103.16
118    FE81         1.00      4.07    45.570      49.640     -58.619      403.00
119    FEI10       57.51      4.07    45.570      49.640     -13.150      151.20
120    FEI20       10.39      4.07    45.570      49.640     -43.048      206.32
121    FEI30       15.17      4.07    45.570      49.640     -40.015       70.87
122    FEI40       28.22      4.07    45.570      49.640     -55.340     1253.70
123    FEI50        7.98      4.07    45.570      49.640     -74.922     5812.54
124    GA102       61.49     50.37    97.740     148.110    -114.801      196.87
125    GA110       20.12     50.37    97.740     148.110    -142.447       88.99
126    GA124      113.78     50.37    97.740     148.110     -85.417       44.10
127    GA13       109.29     50.37    97.740     148.110     -90.472       83.47
128    GA130       25.99     50.37    97.740     148.110    -140.067      119.70
129    GA14        72.50     50.37    97.740     148.110    -112.749       39.38
130    GA143       39.91     50.37    97.740     148.110    -134.973      373.27
131    GA151       95.88     50.37    97.740     148.110    -102.054       40.16
132    GA201      398.49     50.37    97.740     148.110     -18.277    14508.00
133    GA24        80.95     50.37    97.740     148.110    -106.461      114.97
134    GA35        57.75     50.37    97.740     148.110    -112.436       40.82
135    GA40        55.77     50.37    97.740     148.110    -126.905       59.06
136    GA41        66.30     50.37    97.740     148.110    -118.452       78.75
137    GA44       109.79     50.37    97.740     148.110     -88.579      137.81
138    GA46       131.15     50.37    97.740     148.110     -99.339      123.00
139    GA79        85.00     50.37    97.740     148.110    -104.050      400.84
140    GA81        60.75     50.37    97.740     148.110    -116.006      307.12
141    GA92        44.71     50.37    97.740     148.110    -132.060       80.32
142    GL11        46.39      4.07    45.570      49.640     -36.380      472.00
143    GL201       26.00      4.07    45.570      49.640     -27.033      126.50
144    GL221       53.95      4.07    45.570      49.640     -30.616      579.00
145    HI269        9.66      4.07    45.570      49.640     -63.458     2708.00
146    JB111       32.00      4.07    45.570      49.640     -33.414      103.16
147    JB21        25.78      4.07    45.570      49.640     -40.547       21.26
148    JB231       20.01      4.07    45.570      49.640     -48.151       72.45
149    JB232       20.01      4.07    45.570      49.640     -48.151       72.45
150    JB261       29.94      4.07    45.570      49.640     -30.643       44.10
151    JB281       45.35     11.73    45.570      57.300     -17.868       16.10
152    JB309        3.00      4.07    45.570      49.640     -54.936       35.44
153    JB61        47.00     11.73    45.570      57.300     -35.333      216.56
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 SCENARIO C; WEIGHTED REC; RETURNS, .425-FLOOD .2125-SPRINK ;75 MILL POWER  5
                                           16:50 Wednesday, October 30, 1991

OBS    CODE       VALUE    VALREC     VALHY    INSTREAM        NET    DIVERSN2

154    JB12       23.77      4.07    45.570      49.640    -53.089     1271.81
155    JB83       75.02      4.07    45.570      49.640     -8.944      315.79
 56    JV17      114.82     50.37    97.740     148.110    -54.814       74.17
 57    JV18      108.19     50.37    97.740     148.110    -59.589       43.70
158    JV201      33.07     50.37    97.740     148.110   -141.422    11022.00
159    JV202      85.42     50.37    97.740     148.110   -117.525    12177.00
 60    JV203      43.42     50.37    97.740     148.110   -134.911     5313.00
161    JV204      73.85     50.37    97.740     148.110   -107.103      553.61
162    JV25       98.39     50.37    97.740     148.110    -94.201       46.46
 63    JV55       62.14     50.37    97.740     148.110   -117.080      151.20
164    JV63       79.01     50.37    97.740     148.110   -108.914       77.96
165    JV80       90.89     50.37    97.740     148.110    -75.450       38.53
 66    JV81       88.86     50.37    97.740     148.110   -108.754      125.21
 67    JV95       49.42     50.37    97.740     148.110   -120.334     1377.34
168    LC11       29.23     11.73    88.605     100.335    -89.811       63.00
 69    LC131      32.62     11.73    88.605     100.335    -91.104      151.00
 70    LC210      41.55     11.73    88.605     100.335    -83.248      116.55
171    LC251       6.00     11.73    88.605     100.335   -104.105      281.00
172    LCI10      29.80     11.73    88.605     100.335    -99.412      185.00
 73    LCI20      52.06     11.73    88.605     100.335    -67.303      279.56
174    LI161      52.38      4.07    45.570      49.640    -35.909     1043.00
175    LI162      46.40      4.07    45.570      49.640    -41.476      690.00
 76    LI261      15.53      4.07    45.570      49.640    -56.051     3241.00
177    LI262      20.48      4.07    45.570      49.640    -56.997     1401.00
178    LI263      29.80      4.07    45.570      49.640    -49.918      269.00
 79    LI91        9.33      4.07    45.570      49.640    -63.975      503.00
 80    LM20      156.19      4.07    45.570      49.640     78.691     4686.25
181    MEI11      18.48     11.73    88.605     100.335   -101.216     1247.00
182    MEI12      33.48     11.73    88.605     100.335    -90.320      206.32
 83    MEI20      19.30     11.73    88.605     100.335   -101.798      303.00
184    PO171      69.26      4.07    45.570      49.640    -20.939      252.00
185    PO211      27.00      4.07    45.570      49.640    -44.775      102.37
 86    PO251      31.00      4.07    45.570      49.640    -36.609       74.02
187    PO271      36.23      4.07    45.570      49.640    -26.652       88.20
188    PO411      28.85      4.07    45.570      49.640    -44.262      200.81
 89    PO421      33.58      4.07    45.570      49.640    -45.751      425.00
 90    PO91        4.00      4.07    45.570      49.640    -55.316      117.00
191    POI10      57.30      4.07    45.570      49.640    -13.283      556.76
 92    TE101      56.64      4.07    45.570      49.640    -13.702      151.20
 93    TE181      46.63     11.73    88.605     100.335    -81.832      348.86
194    TE183      34.70     11.73    88.605     100.335    -97.075     1353.00
195    TE281      16.41      4.07    45.570      49.640    -39.228       84.26
 96    TE282      22.37      4.07    45.570      49.640    -45.940      163.80
197    TE321      70.55      4.07    45.570      49.640    -11.046      729.23
198    TE361      41.00      4.07    45.570      49.640    -32.318      256.72
 99    TE401      21.00      4.07    45.570      49.640    -44.113      380.00
 00    TE411      29.04      4.07    45.570      49.640    -31.214       92.14
201    TE571      40.78     11.73    88.605     100.335    -88.844     1593.00
202    TE581      52.06      4.07    45.570      49.640    -23.927      233.89
 03    TE591     115.11      4.07    45.570      49.640     19.536     1968.75
204    TE81        4.74      4.07    45.570      49.640    -54.230       16.54
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SCENARIO C; WEIGHTED REC; RETURNS, .425-FLOOD .2125-SPRINK ;75 MILL POWER   6
                                                16:50 Wednesday, October 30, 1991

OBS     CODE       VALUE    VALPEI      VALHY    INSTREAM        NET     DIVERSNO

205     TEI10      40.41      4.07     45.570      49.640   -29.8773       358.00
206     TEI100     38.42     11.73     88.605     100.335   -75.9575       136.24
207     TEI20      24.66      4.07     45.570      49.640   -33.9932       187.42
208     TEI30      38.79      4.07     45.570      49.640   -40.0572      3194.00
209     TEI40      53.83      4.07     45.570      49.640   -20.9064        99.22
210     TEI50      42.29      4.07     45.570      49.640   -33.0499       371.70
211     TEI60      43.19      4.07     45.570      49.640   -35.0566      1185.19
212     TEI70      22.54      4.07     45.570      49.640   -48.2724       472.50
213     TEI80      52.90     11.73     88.605     100.335   -66.7700       196.87
214     TEI90      33.93     11.73     88.605     100.335   -83.3700       119.00
215     T0211      -2.70      4.07     45.570      49.640   -73.1972      1476.00
216     T0221      22.29      4.07     45.570      49.640   -46.0388       120.49
217     T0341      49.02      4.07     45.570      49.640   -34.4559       488.00
218     T0342      17.90      4.07     45.570      49.640   -55.8685       561.00
219     T0421       8.00      4.07     45.570      49.640   -45.6400       112.00
220     VAS1       16.33      4.07     45.570      49.640   -50.6283     92000.00
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EXHIBIT 8

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                                        A  A
                                        R  R       D
                      R                 S  S       I  S
                      E        V     H  E  E       V  P          P
      C               T        A     Y  N  N       E  R          O      F
  O   O               U        L  R  D  I  I       R  I          W      U
  B   D            I  R        U  E  R  C  C       S  N          E      E
  S   E            D  N        E  C  O  1  2       N  K          R      L

   1  BELGRADE     2  0   590.00  2  2  0  0       0  0       0.00      0
   2  BOZEMAN      1  0   590.00  2  2  0  0       0  0       0.00      0
   3  BR101       31  1    28.05  1  2  0  1   11515  1    4293.00      0
   4  BR103       43  1    51.16  2  2  1  1    5066  1     753.50      0
   5  BR104       52  1   -27.39  2  2  1  1   22491  1    7766.40      0
   6  BR106       45  1    45.17  2  2  1  1     676  1     243.63      0
   7  BR107       46  1    39.11  2  2  1  1     278  1      97.39      0
   8  BR108       44  1    50.21  2  2  1  1     229  1      60.91      0
   9  BR109       51  1    20.32  2  2  1  1     258  1     121.81      0
  10  BR11        42  1    53.74  2  2  1  1     119  1      54.82      0
  11  BR110       48  1    35.40  2  2  1  1     467  1     213.18      0
  12  BR111       41  1     8.83  2  2  1  1      80  1      36.54      0
  13  BR12        50  1   -26.60  2  2  1  1     159  1      73.09      0
  14  BR14        47  1    35.87  2  2  1  1     746  1     365.44      0
  15  BR28        57  1    40.66  2  2  0  1     249  1      93.02      0
  16  BR29        58  0    13.46  2  2  0  1      84  0      24.36      0
  17  BR34        39  0    68.38  2  2  1  1     497  1      99.67      0
  18  BR35        59  0    29.25  2  2  0  1     497  1     186.04      0
  19  BR38        38  0    92.51  2  2  1  1     109  1      21.81      0
  20  BR40        54  1    62.60  2  2  0  1     126  1      47.69      0
  21  BR41        53  1    65.61  2  2  0  1     506  1     208.66      0
  22  BR42        55  0    59.26  2  2  0  1      81  1      17.89      0
  23  BR44        56  1    36.35  2  2  0  1    1243  1     598.00      0
  24  BR5         49  1    35.05  2  2  1  1     362  1     152.27      0
  25  BR50        40  0    50.39  2  2  0  1     596  1     182.72      0
  26  BR52        27  0    50.68  1  2  0  1      80  1      24.36      0
  27  BS31       152  0     2.92  3  4  0  1      74  1       0.00    880
  28  BS32       147  1    15.78  3  4  0  1    1506  1     822.50      0
  29  BSS2       153  1     0.46  3  4  0  1   44608  1   25584.00      0
  30  BUREC      203  0    21.75  3  4  1  1       0  0       0.00      0
  31  CH181      213  0     0.00  0  0  0  0      38  1       0.00      0
  32  CH201      210  1    54.31  3  4  0  1      77  1       0.00      0
  33  CH21       194  0    71.26  3  4  1  1     406  1      58.31      0
  34  CH211      204  0    15.84  3  4  1  1     382  1       0.00   7600
  35  CH371      208  0     2.22  3  4  1  0      30  1       4.95      0
  36  CH381      190  1     6.94  3  4  0  1    1912  1     746.10      0
  37  CH511      206  1    12.06  3  4  1  1    1577  1    1088.26      0
  38  CH541      211  0     9.87  3  4  0  1      37  1       0.00    480
  39  CH551      212  1    67.84  3  4  0  1      86  1       0.00      0
  40  CH641      192  0   -10.09  3  4  0  1      53  1       0.00    610
  41  CHESTER    159  0   590.00  3  4  0  0       0  0       0.00      0
  42  CHI10      200  0    37.14  3  4  1  1     314  1      80.62      0
  43  CHI21      198  0    45.98  3  4  1  1     752  1     201.45      0
  44  CHI22      199  0    40.50  3  4  1  1     389  1     106.91      0
```

OBS	CODE	ID	RETURN	VALUE	REC	HYDRO	ARSENIC1	ARSENIC2	DIVERSN	SPRINK	POWER	FUEL
45	CHI30	196	0	50.58	3	4	1	1	643	1	109.38	0
46	CHI40	197	0	48.69	3	4	1	1	290	1	0.00	2900
47	CHI51	143	0	39.50	3	4	0	1	244	1	0.00	3200
48	CHI52	149	0	15.21	3	4	0	1	255	1	0.00	1340
49	CHI53	140	0	53.98	3	4	0	1	289	1	0.00	2900
50	CHI61	179	0	41.74	3	4	0	1	247	1	0.00	2450
51	CHI72	178	0	41.74	3	4	0	1	107	1	0.00	930
52	CHI74	184	0	38.39	3	4	0	1	106	1	0.00	1000
53	CHI80	175	0	46.37	3	4	0	1	122	1	0.00	1150
54	CHOTEAU	169	0	590.00	3	4	0	0	0	0	0.00	0
55	CHS1	133	1	0.60	4	2	0	0	3117	1	2038.49	0
56	CHS3	202	1	26.54	3	4	1	1	19654	1	3593.32	0
57	CHS5	201	1	29.13	3	4	1	1	9058	1	7118.84	0
58	CHS6	209	1	-4.62	3	4	1	1	35814	1	20206.84	0
59	CONRAD	156	0	590.00	3	4	0	0	0	0	0.00	0
60	CS101	65	0	79.74	2	3	1	1	304	1	39.55	0
61	CS102	72	0	55.75	2	3	1	1	186	1	44.55	0
62	CS111	69	0	66.27	2	3	1	1	799	1	191.52	0
63	CS159	132	0	33.64	4	2	0	1	114	1	19.00	0
64	CS171	112	0	27.77	2	3	0	1	70	1	15.10	0
65	CS21	128	0	1.42	2	3	0	1	140	1	0.00	3000
66	CS231	119	0	5.95	2	3	0	1	26	1	5.07	0
67	CS241	105	0	39.39	2	3	0	1	190	1	41.68	0
68	CS251	93	1	35.87	2	3	0	1	245	1	76.24	0
69	CS252	91	0	42.35	2	3	0	1	77	1	15.94	0
70	CS271	89	0	53.06	2	3	0	1	134	1	29.89	0
71	CS31	116	0	15.66	2	3	0	1	94	1	18.31	0
72	CS32	117	0	9.12	2	3	0	1	87	1	17.88	0
73	CS331	92	0	38.35	2	3	0	1	57	1	11.34	0
74	CS351	75	0	51.64	2	3	0	1	369	1	76.84	0
75	CS42	131	0	38.71	4	2	0	1	443	0	24.20	0
76	CS43	129	0	64.21	4	2	0	1	599	1	157.15	0
77	CS44	130	0	43.30	4	2	0	1	83	1	0.00	640
78	CS471	115	0	23.22	2	3	0	1	126	1	38.37	0
79	CS51	118	0	7.55	2	3	0	1	177	1	34.29	0
80	CS52	114	0	24.01	2	3	0	1	90	1	22.41	0
81	CS541	70	0	61.88	2	3	1	1	69	1	13.72	0
82	CS61	87	0	70.53	2	3	0	1	163	1	17.89	0
83	CS62	99	0	42.04	2	3	0	1	141	1	25.22	0
84	CS63	101	0	32.74	2	3	0	1	129	1	6.98	0
85	CS64	100	0	33.56	2	3	0	1	100	1	21.63	0
86	CS71	95	0	24.80	2	3	0	1	42	1	13.95	0
87	CSI101	66	0	75.63	2	3	1	1	223	1	29.36	0
88	CSI102	88	0	56.58	2	3	0	1	171	1	34.90	0

OBS	CODE	ID	RETURN	VALUE	REC	HYDRO	ARSENIC1	ARSENIC2	DIVERSN	SPRINK	POWER	FUEL
89	CSI103	68	0	68.14	2	3	0	0	557	1	90.77	0
90	CSI11	74	0	52.37	2	3	1	1	28743	1	62.62	0
91	CSI111	90	0	44.55	2	3	0	1	843	1	197.04	0
92	CSI12	80	0	37.24	2	3	1	1	110	1	20.88	0
93	CSI120	96	0	20.78	2	3	0	1	133	1	30.75	0
94	CSI21	76	0	46.94	2	3	1	1	157	1	36.72	0
95	CSI22	73	0	53.24	2	3	1	1	163	1	36.99	0
96	CSI23	82	0	35.16	2	3	1	1	144	1	33.75	0
97	CSI31	81	0	36.67	2	3	1	1	109	1	18.03	0
98	CSI32	85	0	15.67	2	3	1	1	86	1	29.49	0
99	CSI33	84	0	21.51	2	3	1	1	150	1	39.18	0
100	CSI34	83	0	30.04	2	3	1	1	164	1	32.46	0
101	CSI35	77	0	44.55	2	3	1	1	253	1	32.46	0
102	CSI41	79	0	37.70	2	3	1	1	180	1	39.40	0
103	CSI51	71	0	55.90	2	3	1	1	250	1	61.96	0
104	CSI52	67	0	73.37	2	3	1	1	700	1	96.24	0
105	CSI71	111	0	29.87	2	3	0	1	198	1	64.96	0
106	CSI81	108	0	32.13	2	3	0	1	96	1	20.76	0
107	CSI82	109	0	31.37	2	3	0	1	137	1	24.05	0
108	CSI83	104	0	46.67	2	3	0	1	99	1	16.39	0
109	CSI91	110	0	29.90	2	3	0	1	129	1	23.83	0
110	CSI92	113	0	26.98	2	3	0	1	72	1	10.36	0
111	CSS200	120	1	-0.42	2	3	0	1	11885	1	8958.43	0
112	CUTBANK	136	0	590.00	3	4	0	0	0	0	0.00	0
113	DILLON	37	0	590.00	2	2	0	0	0	0	0.00	0
114	EAST HELENA	63	0	590.00	2	3	0	0	0	0	0.00	0
115	FARFIELD	124	0	590.00	2	3	0	0	0	0	0.00	0
116	FE111	232	0	0.63	3	4	0	1	25	1	0.00	257
117	FE141	218	0	64.49	3	4	0	1	375	1	6.34	0
118	FE161	235	0	32.64	3	4	0	1	261	1	27.27	0
119	FE401	234	1	38.86	3	4	0	1	64	1	11.49	0
120	FE41	217	1	1.51	3	4	0	1	103	1	56.60	0
121	FE42	223	0	-7.00	3	4	0	1	44	1	0.00	628
122	FE431	219	0	41.63	3	4	0	1	107	1	26.55	0
123	FE561	237	1	0.00	3	4	0	1	382	1	196.68	0
124	FE671	220	0	49.12	3	4	0	1	748	1	233.16	0
125	FE672	221	0	51.81	3	4	0	1	444	1	78.67	0
126	FE673	222	0	51.60	3	4	0	1	131	1	24.14	0
127	FE81	224	1	1.00	3	4	0	1	403	1	109.14	0
128	FEI10	195	0	57.51	3	4	1	1	192	1	0.00	2600
129	FEI20	207	0	10.39	3	4	1	0	262	1	0.00	5500
130	FEI30	205	0	15.17	3	4	1	1	90	1	0.00	1100
131	FEI40	236	0	28.22	3	4	0	1	1592	1	845.55	0
132	FEI50	216	0	7.98	3	4	0	1	7381	1	5039.51	0

```
                                                        A    A
                                                        R    R         D
                                 R                      S    S         I    S
                                 E       V         H    E    E         V    P              P
       C                         T       A         Y    N    N         E    R              O         F
 O     O                         U       L    R    D    I    I         R    I              W         U
 B     D                    I    R       U    E    R    C    C         S    N              E         E
 S     E                    D    N       E    C    O    1    2         N    K              R         L

133   FT BENTON           193    0  590.00    3    4    0    0         0    0           0.00         0
134   GA102                26    0   61.49    1    2    0    1       250    1          32.10         0
135   GA110                18    0   20.12    1    2    0    1       113    1          18.06         0
136   GA124                 4    0  113.78    1    2    0    1        56    1          11.97         0
137   GA13                  6    0  109.29    1    2    0    1       106    1          27.92         0
138   GA130                17    0   25.99    1    2    0    1       152    1          28.89         0
139   GA14                 10    0   72.50    1    2    0    1        50    1          11.97         0
140   GA143                16    0   39.91    1    2    0    1       474    1         129.96         0
141   GA151                 7    0   95.88    1    2    0    1        51    1          16.96         0
142   GA201                20    1  398.49    1    2    1    1     12249    1       15912.31         0
143   GA24                  9    0   80.95    1    2    0    1       146    1          31.91         0
144   GA35                 13    0   57.75    1    2    0    1        71    0          16.96         0
145   GA40                 14    0   55.77    1    2    0    1        75    1          23.93         0
146   GA41                 11    0   66.30    1    2    0    1       100    1          27.92         0
147   GA44                  5    0  109.79    1    2    0    1       175    1          39.89         0
148   GA46                  3    0  131.15    1    2    0    1       100    1          15.96         0
149   GA79                  8    0   85.00    1    2    0    1       509    1         113.06         0
150   GA81                 12    0   60.75    1    2    0    1       390    1          56.53         0
151   GA92                 15    0   44.71    1    2    0    1       102    1          28.27         0
152   GL11                138    1   46.39    3    4    0    1       472    1         133.98         0
153   GL201               154    0   26.00    3    4    0    1       220    0           0.00         0
154   GL221               137    1   53.95    3    4    0    1       579    1         131.54         0
155   GREAT FALLS         102    0  590.00    2    3    0    0         0    0           0.00         0
156   GREAT FALLS          64    0  590.00    2    3    0    0         0    0           0.00         0
157   HELENA               62    0  590.00    2    3    0    0         0    0           0.00         0
158   HI269               150    1    9.66    3    4    0    1      2708    1        1442.80         0
159   JB111               225    0   32.00    3    4    0    1       131    1          12.02         0
160   JB21                228    0   25.78    3    4    0    1        27    1           4.41         0
161   JB231               229    0   20.01    3    4    0    1        92    1          23.20         0
162   JB232               230    0   20.01    3    4    0    1        92    1          23.20         0
163   JB261               227    0   29.34    3    4    0    1        56    1           0.00      -999
164   JB281               134    0   45.35    4    2    0    1        28    0           0.00      -999
165   JB309               231    0    3.00    3    4    0    1        45    1           7.29         0
166   JB61                135    0   47.11    4    2    0    1       275    1          48.60         0
167   JBI2                215    0   23.77    3    4    0    1      1615    1         573.38         0
168   JBS3                226    0   75.02    3    4    0    1       401    1          62.29         0
169   JV17                 32    0  114.82    1    2    0    1       129    0          13.86         0
170   JV18                 33    0  108.19    1    2    0    1        76    0           6.93         0
171   JV201                30    1   33.07    1    2    0    0     11022    1        3101.00         0
172   JV202                23    1   85.41    1    2    0    1     12177    1        4218.50         0
173   JV203                29    1   43.42    1    2    0    1      5313    1        1291.90         0
174   JV204                24    0   73.85    1    2    0    1       703    1          92.55         0
175   JV25                 22    0   98.39    1    2    0    1        59    1          11.31         0
176   JV55                 25    0   62.14    1    2    0    1       192    1          36.28         0
```

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                                             A   A
                                             R   R     D
                       R                     S   S     I    S
                       E       V         H   E   E     V    P        P
     C                 T       A         Y   N   N     E    R        O       F
 O   O                 U       L     R   D   I   I     R    I        W       U
 B   D             I   R       U     E   R   C   C     S    N        E       E
 S   E             D   N       E     C   O   1   2     N    K        R       L

177  JV63         36   0     79.01   1   2   0   1     99   1     24.36      0
178  JV80         34   0     90.89   1   2   0   1     67   0      7.01      0
179  JV81         35   0     88.86   1   2   0   1    159   1     60.91      0
180  JV95         28   0     49.42   1   2   0   1   1749   1    140.91      0
181  LC11         60   0     29.23   2   3   0   1     80   1     14.44      0
182  LC131       121   1     32.62   2   3   0   1    151   1     30.54      0
183  LC210        78   0     41.55   2   3   1   1    148   1     30.89      0
184  LC251       122   1      6.00   2   3   0   1    281   1     54.35      0
185  LCI10        61   1     29.30   2   3   0   1    185   1     73.88      0
186  LCI20        86   0     52.06   2   3   0   1    355   1      0.00   4800
187  LEWISTOWN   233   0    590.00   3   4   0   0      0   9      0.00      0
188  LI161       141   1     52.38   3   4   0   1   1043   1    371.28      0
189  LI162       142   1     46.40   3   4   0   1    690   1    296.43      0
190  LI261       148   1     15.53   3   4   0   1   3241   1   1312.73      0
191  LI262       146   1     20.48   3   4   0   1   1401   1    704.37      0
192  LI263       144   1     29.80   3   4   0   1    269   1    116.65      0
193  LI91        151   1      9.33   3   4   0   1    503   1    273.06      0
194  LM20        238   0    156.19   3   4   0   1   8150   0   1001.00      0
195  MEI11        98   1     18.48   2   3   0   1   1247   1    360.60      0
196  MEI12        94   0     33.48   2   3   0   1    262   1     66.19      0
197  MEI20        97   1     19.30   2   3   0   1    303   1     96.21      0
198  PO171       163   1     69.26   3   4   0   1    252   1     42.69      0
199  PO211       155   0     27.00   3   4   0   1    130   1     35.88      0
200  PO251       164   0     31.00   3   4   0   1     94   1     14.04      0
201  PO271       167   0     36.23   3   4   0   1    112   1      0.00   1150
202  PO411       168   0     28.85   3   4   0   1    255   1     74.17      0
203  PO421       166   1     33.58   3   4   0   1    425   1    156.66      0
204  PO91        158   1      4.00   3   4   0   1    117   1     25.66      0
205  POI10       165   0     57.30   3   4   0   1    707   1      0.00   8775
206  POWER       123   0    590.00   2   3   0   0      0   0      0.00      0
207  SHELBY      139   0    590.00   3   4   0   0      0   0      0.00      0
208  TE101       172   0     56.64   3   4   0   1    192   1      0.00   1640
209  TE181       126   0     46.63   2   3   0   1    443   1    110.48      0
210  TE183       127   1     34.70   2   3   0   1   1353   1    544.68      0
211  TE281       189   0     16.41   3   4   0   1    107   1      0.00   1490
212  TE282       188   0     22.37   3   4   0   1    208   1     49.11      0
213  TE321       171   0     70.55   3   4   0   1    926   1    128.56      0
214  TE361       181   0     41.00   3   4   0   1    326   1     63.76      0
215  TE401       180   1     21.00   3   4   0   1    380   1     53.99      0
216  TE411       185   0     29.04   3   4   0   1    117   1      0.00   1500
217  TE571       125   1     40.78   2   3   0   1   1593   1    405.05      0
218  TE581       174   0     52.06   3   4   0   1    297   1     48.91      0
219  TE591       170   0    115.11   3   4   0   1   2500   1    217.18      0
220  TE81        191   0      4.74   3   4   0   1     21   1      3.59      0
```

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                                                A  A
                                                R  R     D
                              R                 S  S     I   S
                              E       V      H  E  E     V   P        P
     C                        T       A      Y  N  N     E   R        O      F
 O   O                        U       L   R  D  I  I     R   I        W      U
 B   D                     I  R       U   E  R  C  C     S   N        E      E
 S   E                     D  N       E   C  O  1  2     N   K        R      L

221  TEI10               182  1    40.41  3  4  0  1    358  1    106.81     0
222  TEI100              106  0    38.42  2  3  0  1    173  1      0.00  1900
223  TEI20               186  0    24.66  3  4  0  1    238  1      0.00  3000
224  TEI30               183  1    38.79  3  4  0  1   3194  1    895.43     0
225  TEI40               173  0    53.83  3  4  0  1    126  1     15.37     0
226  TEI50               177  0    42.29  3  4  0  1    472  1    108.78     0
227  TEI60               176  0    43.19  3  4  0  1   1505  1    434.14     0
228  TEI70               187  0    22.54  3  4  0  1    600  1    174.61     0
229  TEI80               103  0    52.90  2  3  0  1    250  1      0.00  3500
230  TEI90               107  1    33.93  2  3  0  1    119  1      0.00  1600
231  THREE FORKS          21  0   590.00  2  2  0  0      0  0      0.00     0
232  T0211               162  1    -2.70  3  4  0  1   1476  1    936.51     0
233  T0221               145  0    22.29  3  4  0  1    153  1     36.29     0
234  T0341               160  1    49.02  3  4  0  1    488  1    130.03     0
235  T0342               161  1    17.90  3  4  0  1    561  1    243.29     0
236  T0421               157  1     8.00  3  4  0  1    112  1      0.00  1360
237  VAS1                239  1    16.33  3  4  1  1  92000  1  24060.15     0
238  WEST YELLOW          19  0   590.00  2  2  0  0      0  0      0.00     0
239  WINIFRED            214  0   590.00  3  4  0  0      0  0      0.00     0
```

EXHIBIT 9

```
libname missouri 'c:\sas2\missouri\';
data missouri.main;
  set missouri.irgate;
IF SPRINK=9 THEN SPRINK=.;
if id=1 then diversn=6000;
if id=2 then diversn=645;
if id=19 then diversn=2550;
if id=21 then diversn=81;
if id=37 then diversn=202;
if id=62 then diversn=7071;
if id=63 then diversn=258;
if id=64 then diversn=10642;
if id=102 then diversn=467;
if id=123 then diversn=62;
if id=124 then diversn=100;
if id=136 then diversn=890;
if id=139 then diversn=302;
if id=156 then diversn=1322;
if id=159 then diversn=435;
if id=169 then diversn=482;
if id=193 then diversn=124;
if id=214 then diversn=60;
if id=233 then diversn=2966;
IF ID=74 THEN DIVERSN=287;
if rec=4 and hydro=2 then do;
rec=2; hydro=4;
end;
if value=590 and rec=2 and hydro=2 then rec=1;
if value=590 then use=1;else use=2;
if value=590 then do;
  if rec=1 then valrec=22.30;
  if rec=2 then valrec=9.54;
  if rec=3 then valrec=2.33;
  if hydro=1 then valhy=69.16;
  if hydro=2 then valhy=65.16;
  if hydro=3 then valhy=59.07;
  if hydro=4 then valhy=30.38;
end;
if rec=1 and valrec lt 1 then valrec=50.37;
if rec=2 and valrec lt 1 then valrec=11.73;
if rec=3 and valrec lt 1 then valrec=4.07;
if hydro=1 then valhy=69.16;
if hydro=2 then valhy=65.16;
if hydro=3 then valhy=59.07;
if hydro=4 then valhy=30.38;

TITLE1 'SCENARIO C; WEIGHTED REC; RETURNS, .425-FLOOD .2125-SPRINK ;75 MILL POWE
R';

VALHY=VALHY*1.5;
RUN=3;
X=.075;

IF USE=2 THEN DO;
IF RUN=1 THEN DIVERSN2=DIVERSN/2;
IF RUN=2 THEN DO;
```

```
   IF SPRINK IN(1,.) THEN VALUE2=VALUE/2 AND DIVERSN2=DIVERSN;
   ELSE DIVERSN2=DIVERSN/2 AND VALUE2=VALUE;
ND;
ND;
F USE=2 THEN DO;
F RUN=3 THEN DO;
   IF RETURN=0 AND SPRINK IN(1,.) THEN DO;
      VALUE2=(VALUE/2)*1.269; DIVERSN2=DIVERSN*.7875;END;
   ELSE DO;
      VALUE2=(VALUE/2)*1.739; DIVERSN2=DIVERSN*.575;END;
END;
END;
   IF RETURN=1 THEN DO;VALUE2=VALUE/2;DIVERSN2=DIVERSN;END;
F USE=1 THEN DO; VALUE2=VALUE;DIVERSN2=DIVERSN;END;
F CODE='GA46' THEN DO; VALUE2=(VALUE/2)*.813;DIVERSN2=123;END;
F CODE='GA201' THEN DO; VALUE2=(VALUE/2)*.8442928;DIVERSN2=14508;END;
F POWER=. THEN POWER=0;
EPLACE=((POWER*1000)*(X-.04))/DIVERSN2;
NSTREAM=VALREC+VALHY;
ET=VALUE2-INSTREAM-REPLACE;
F NET GE 0 THEN PASS=1;
GREPLACE=REPLACE*DIVERSN2;
grec=valrec*diversn2;
ghydro=valhy*diversn2;
GVALUE=VALUE2*DIVERSN2;
GNET=GVALUE-GHYDRO-GREC-GREPLACE;
ount=1;
F USE=2 ;
ROC PRINT;VAR CODE VALUE VALREC VALHY INSTREAM NET DIVERSN2;RUN;
F NET GE 0 THEN CLASS=1;ELSE CLASS=2;
roc sort;by use CLASS ;

roc summary nway;
 class count;
 var gvalue grec ghydro GREPLACE PASS;
 by use CLASS;
 output out=out1 sum=sumval sumrec sumhydro SUMREPL  SPASS;
ATA STUFF;
  SET WORK.OUT1;
SUMREC=(SUMREC*22.109708);
UMHYDRO=(SUMHYDRO*22.109708);
UMVAL=(SUMVAL*22.109708);
SUMGNET=(SUMGNET*22.109708);
UMREPL=(SUMREPL*22.109708);
roc print;
var sumval sumrec sumhydro SUMREPL  SPASS;
y use CLAss;
un;
```

Exhibit 10:

Summary of DFWP Instream flow reservation requests with no competing requests; Drainage level aggregation.

16:50 Wednesday, October 30, 1991

```
OBS DRAINAGE            ANNUAL   MOUTH    TRIBS TRRATIO MORATIO TOTNEV    CALC

  1 BEAVERHEAD          319020  144793  253295   0.794   0.454    5930 2692.22
  2 BIG HOLE            829316  470578  280833   0.597   0.567    7120 4037.04
  3 GALLATIN            583004  289587  260412   0.447   0.497   13015 6468.46
  4 JEFFERSON          1586430  796363   66389   0.042   0.502    2307 1158.11
  5 MADISON             748578  361983  233263   0.312   0.484   20360 9854.24
  6 MIDDLE MISSOURI    5611100 3644205   30647   0.005   0.650    5403 3511.95
  7 MARIAS              607301  361983  162170   0.267   0.596     348  207.41
  8 MUSSELLSHELL        156567   57917   81881   0.523   0.399     628  250.57
  9 SMITH               113737   57917   62479   0.549   0.509     953  485.08
 10 UPPER MISSOURI     3854094 1737520  198536   0.052   0.451    6376 2875.58
 11 RUBY                157755   73845   67040   0.425   0.468       .       .
 12 SUN                 505742   94116   13032   0.026   0.186       .       .
 13 TETON               105281   25339   36845   0.349   0.241       .       .
```

ANNUAL= average annual discharge at mouth of basin
MOUTH= Requested protected flow at mouth of drainage
TRIBS= Requested protected tributary flow in drainage
TRRATIO=Ratio of TRIBS/ANNUAL
MORATIO=Ratio of MOUTH/ANNUAL
TOTNEV =Total net economic value of fishing in drainage derived from Duffield,Loomis and Brooks 1987
CALC =MORATIO*TOTNEV

EXHIBIT 11

Summary of Corrections to DNRC Draft EIS on Missouri Basin Water Reservation (June 1991) to Achieve Valid Public Interest (Benefit-Cost) Analysis

Issue	Correctly Handled In:		Effect on Results
	Site specific[1] analysis	Aggregate[2] analysis	
1. Arithmetic indicates highest benefits			Wrongly "combination" alternative net
2. Replacement cost of power included	No	Yes	Overstate irrigation benefits at project level
3. Sensitivity shown, of hydropower, replacement costs to 50 mill and 100 mill power	No	No	Only 50 mill overstates range of irrigation net benefit.
4. Instream use net benefits shown and efficient allocation identified	No	No	Net benefits of all alternatives not compared
5. Include effects upstream withdrawals downstream for:			
-hydropower	Yes	Yes	
-recreation	No	No	Understate recreation loss and overstate irrigation net benefit
6. Irrigation return flow assumption consistent with project-level assumption of 50% return			
-hydropower	Yes	N/A	
-recreation	No	N/A	Overstate recreation loss by factor of 2

---

[1] Montana DNRC Draft EIS, Table K-4

[2] Id. Tables S-1, S-2

7. Return flow assumption consistent with DNRC hydrology model	No	No	Understates hydropower and rec. loss by a factor of about 1.58
8. Unquantified costs of consumptive withdrawals to water quality and Fish and Wildlife uses noted in summary	No	No	Inconsistent with ARM 36.16.107B public interest criteria and overstates consumption use

Exhibit 12. Minor computational errors and inconsistencies in DNRC draft EIS on Missouri Basin water reservation (June 1991).

(1) There are 4 inconsistencies between Tables K-3 and K-5.

a. Gallatin River #1 is listed as both having and not having competing reservation requests.

b. Elk Creek in the Sun River drainage is likewise listed.

c. Tenmile Creek in the Three Forks-Holter section of the Missouri drainage is likewise listed.

d. Table K-5 shows Warm Springs Creek in the Three Forks-Holter section of the Missouri drainage as having competing requests but this stream does not appear on the DFWP master list of reservation requests (Table 3-2).

(2) There are 5 computational errors in Table K-4.

a. All instream values on page K-7 of Table K-4 with a value of 86.53 should be 86.97.

b. The Great Falls municipal request on page K-8 should be 66.29 instead of 71.18 for a consumptive value.

c. BR-12 on page K-8, Column A-B should be -103.87 rather than -50.67.

d. LC-11 on page K-8, Column A-B should be -41.95 rather than +45.96.

e. TO-451 on page K-10, Column A-B should be -26.10 rather than +26.10.

EXHIBIT 13

PUBLIC INTEREST

Reservations for municipal water supplies and irrigation would provide monetary benefits to basin communities. However, they would have costs by decreasing streamflows which could adversely effect recreation and hydropower production. Reservations for consumptive uses would also use additional power, which would eventually require the production of higher-cost electricity. The value of an acre-foot of water for instream flow is based on recreation and electricity production. Table S-1 identifies the total benefits and costs of water uses under the three alternatives. Net benefits per year are greatest under the Combination Alternative ($351.8 million), slightly less under the Instream Alternative ($338.5 million) and considerably lower under the Consumptive Use Alternative ($152.7 million).

Municipal water developments have benefits that exceed costs by $341.3 million because of the small amount of water consumed and the high value of this use under all three alternatives (Table S-2). In contrast, proposed irrigation projects consume large amounts of water. Total costs associated with the depletions would exceed total benefits by $188.6 million per year under the Consumptive use Alternative, $27.2 million per year under the Combination Alternative and $2.8 million per year under the Instream Alternative (Table S-2).

The value of an acre-foot of water for instream and consumptive uses can be compared when reservations for the two uses are both requesting the same water. Sixty-two proposed irrigation projects would value an acre-foot of water at a greater level than the instream values, and 157 proposed irrigation projects would value water less than the instream values. The value of an acre-foot of water for all municipal reservations exceeds the instream flow and proposed irrigation project values. Instream flow values are greatest in the Headwaters Subbasin where the recreation value is the highest and where each acre-foot of water can be passed along to be used to generate hydroelectricity at downstream hydropower facilities. Instream values decline progressively with distance downstream but the value of water for irrigation remains more consistent throughout the basin.

On each stream or stream reach, the number of requests that will give the greatest net benefit is based, in part, on the amount of water available. However, water availability may not be definitely known before the Board acts on the reservation requests.

Table S-1. Benefits and costs of water use under three alternatives

	($ million)[a]		
	Consumptive Use	Instream	Combination
Irrigation	134.1	38.7	119.9
Municipal	343.2	343.2	343.2
Recreation	-70.3	-6.7	-35.7
Hydropower Production	-213.4	-27.6	-87.3
Replacement Power	-40.9	-9.1	-18.0
Total	152.7	338.5	351.8

[a] Positive values represent benefits and negative values represent costs.

Table S-2. Benefits and costs of municipal use and irrigation use under three alternatives

	($ million)[a]		
	Consumptive Use	Instream	Combination
Irrigation			
benefits	134.1	38.7	119.9
costs	-322.7	-41.5	-139.1
net	-188.6	-2.8	-27.2
Municipal			
benefits	343.2	343.2	343.2
costs	-1.9	-1.9	-1.9
net	341.3	341.3	341.3

[a] Positive values represent benefits and negative values represent costs.

Exhibit 14. Comparison of DNRC and Corrected model for 50 mill power, assuming 50% return flows.

	Consumptive	Combination (62 pass)
(A) DNRC Draft EIS, Tables S-1, S-2.		
Municipal		
Benefits	343.2	
Costs	-1.9	
Net benefits	341.3	
Irrigation		
Benefits	134.1	111.9
Costs		
Recreation	-69.8[1]	-35.2[1]
Hydropower	-212.0[1]	-85.9[1]
Replacement	-40.9	-18.0
Net benefits	-188.6	-27.2

(B) Corrected DNRC case Scenario A		Efficient	
		Pass (47)	Not (173)
Municipal			
Benefits	452.1		
Costs	-72.5		
Net benefits	379.6		
Irrigation			
Benefits	143.6	80.85	62.70
Costs			
Recreation	-53.1	-8.21	-44.92
Hydropower	-175.1	-18.06	-157.05
Replacement	-34.8	-4.48	-30.28
Net benefits	-119.4	50.1	-169.55

---

[1] Derived from tables S-1, S-2 on the assumption that of the -1.9 in municipal costs, -.5 is recreation and -1.4 is hydropower.

EXHBIT 15

Table K-1 shows the basinwide averages of the value of an acre-foot of water for recreation derived by Duffield et al (1990). A change in flow will have a greater impact on some streams and a smaller impact on others. Table K-2 shows the value of an acre foot of water originating in each subbasin for hydropower production. Table K-3 shows streams with instream requests and no consumptive requests. No other new uses have been identified on these streams. The third column of Table K-3 shows DFWP's fisheries value class rating for each stream. Water in Class 1 and Class 2 streams is likely to be more valuable than the average shown in Table K-3. Water in Class 4 and Class 5 streams is likely to be less valuable than the average shown in Table K-3.

Tables K-4 and K-5 show projects on streams with both instream and consumptive reservation requests. The fourth column in each table shows the value of an acre-foot of water in the proposed use. The value for municipal use is explained later in this appendix. The value for irrigation is derived from DNRC's economic and financial analysis of irrigation projects described in Tubbs, et al (1989). It is the median annual net return divided by the number of acre-feet used by the project. The value for instream requests is the sum of the values for recreation and power production. The value for power production is based on the hydropower losses reported in Chapter 6. The value for recreation is the year-round average of the values from Duffield, et al. (1990) shown in Table K-1. It is one-sixth of the July-August value plus five-sixths of the Rest-of-Year value. These instream values are basinwide averages. An acre-foot will be more valuable in some streams and less valuable in others. Streams that are fisheries Class 1 or 2 are likely to have higher than average values. Streams that are fisheries Class 4, 5, or 6 are likely to have lower than average values. Fisheries value classes for streams with instream requests are shown in the fifth column of Table K-5. The value for irrigation is derived from DNRC's economic and financial analysis of irrigation projects. It is the median annual net return divided by the number of acre-feet used by the project.

The fifth column in Table K-4 shows the value the requested water would have if left in the stream. For municipal requests, it is the same as the value for an instream request in the same location. Irrigation does not withdraw water in the winter. For irrigation requests, it is the simple average of the July-August value and the Rest-of-Year value.

The sixth column in Table K-4 shows the difference between the value in its proposed use and the value of the water left in the stream. For consumptive uses with a higher value than instream use this difference is positive; for consumptive uses with a lower value than instream use this difference is negative.

Table K-6 shows the size of each municipal request in thousand gallons per year, the annual cost attributable to the reservation and the cost per thousand gallons. Municipal use consists of a variety of different uses. The lowest valued municipal use is probably watering lawns. People begin to curtail lawn watering at rates of about $2.50 per thousand gallons. The costs for Conrad, Fairfield, Power and Shelby are all above $2.00 per thousand gallons. The value of water for other uses, such as in cooking, are much higher.

Table K-7 shows characteristics of municipal water systems where reservation requests have been received.

Table K-1. Recreation values per acre-foot at 1989 flows

Subbasin	July and August	Rest of Year
Headwaters	$35.40	$8.23
Upper Missouri	$19.46	$4.76
Marias/Teton	$ 5.81	$1.63
Middle Missouri	$ 5.81	$1.63

Source: Duffield et al. (1990)

Table K-2. Hydropower values per acre foot

Subbasin	Value
Headwaters	$69.16
Upper Missouri	
above Canyon Ferry	$65.16
below Canyon Ferry	$59.07
Marias/Teton	$30.38
Middle Missouri	$30.38

EXHIBIT 16

Table K-4. Comparison of water values for consumptive use and instream use

STREAM	APPLICATION	PURPOSE	A CONSUMPTIVE VALUE $ PER ACRE-FOOT[a]	B INSTREAM VALUE $ PER ACRE-FOOT[b]	A minus B CONSUMPTIVE VALUE MINUS INSTREAM VALUE
GALLATIN RIVER DRAINAGE					
Sourdough Creek	Bozeman	municipal	590.00	77.92	512.08
Wells in Gallatin Valley	Belgrade	municipal	590.00	77.92	512.08
Wells in Gallatin Valley	GA-46	irrigation	131.15	86.53	44.62
Wells in Gallatin Valley	GA-124	irrigation	113.78	86.53	27.25
Wells in Gallatin Valley	GA-44	irrigation	109.79	86.53	23.26
Wells in Gallatin Valley	GA-13	irrigation	109.26	86.53	22.73
Wells in Gallatin Valley	GA-151	irrigation	95.88	86.53	9.35
Wells in Gallatin Valley	GA-79	irrigation	85.00	86.53	-1.53
Wells in Gallatin Valley	GA-24	irrigation	80.95	86.53	-5.58
Wells in Gallatin Valley	GA-14	irrigation	72.50	86.53	-14.03
Wells in Gallatin Valley	GA-41	irrigation	66.30	86.53	-20.23
Wells in Gallatin Valley	GA-81	irrigation	60.75	86.53	-25.78
Wells in Gallatin Valley	GA-35	irrigation	57.75	86.53	-28.78
Wells in Gallatin Valley	GA-40	irrigation	55.77	86.53	-30.76
Wells in Gallatin Valley	GA-92	irrigation	44.71	86.53	-41.82
Wells in Gallatin Valley	GA-143	irrigation	39.91	86.53	-46.62
Wells in Gallatin Valley	GA-130	irrigation	25.99	86.53	-60.54
Wells in Gallatin Valley	GA-110	irrigation	20.12	86.53	-66.41
MADISON RIVER DRAINAGE					
Whiskey Springs	West Yellowstone	municipal	590.00	77.92	512.08
Madison River	GA-201	irrigation	398.49	86.53	311.96
JEFFERSON RIVER DRAINAGE					
Well near Jefferson River	Three Forks	municipal	590.00	77.92	512.08
Jefferson River	JV-25	irrigation	98.39	86.53	11.86
Jefferson River	JV-202	irrigation	85.42	86.53	-1.11
Jefferson River	JV-204	irrigation	73.85	86.53	-12.68
Jefferson River	JV-55	irrigation	62.14	86.53	-24.39
Jefferson River	GA-102	irrigation	61.49	86.53	-25.04
Jefferson River	BR-52	irrigation	50.68	86.53	-35.85
Jefferson River	JV-95	irrigation	49.42	86.53	-37.11
Jefferson River	JV-203	irrigation	43.42	86.53	-43.11
Jefferson River	JV-201	irrigation	33.07	86.53	-53.46
Jefferson River	BR-101	irrigation	28.05	86.53	-58.48
Wells near Boulder River	JV-17	irrigation	114.82	86.53	28.29
Wells near Boulder River	JV-18	irrigation	108.19	86.53	21.66
Wells near Boulder River	JV-80	irrigation	90.89	86.53	4.36
Wells near Boulder River	JV-81	irrigation	88.86	86.53	2.33
Wells near Boulder River	JV-63	irrigation	79.01	86.53	-7.52
BEAVERHEAD RIVER DRAINAGE					
Beaverhead River	Dillon	municipal	590.00	77.92	512.08
MISSOURI RIVER DRAINAGE - THREE FORKS TO HOLTER DAM					
Missouri River	BR-38	irrigation	92.51	77.27	15.24
Missouri River	BR-34	irrigation	68.38	77.27	-8.89
Missouri River	BR-50	irrigation	50.39	77.27	-26.88
Missouri River	BR-111	irrigation	8.83	77.27	-68.44
Canyon Ferry Reservoir	BR-11	irrigation	53.74	77.27	-23.53

Exhibit 17. Example of correction to DNRC estimates of irrigation project level consumptive benefits. Correction for assumed amount of water consumed and for replacement cost of power. Projects GA-46 and GA-201.

I. Correction for water consumed.

	Net annual benefits of project	Water diversion applic.	Water consumed by project	Irr. value per acre-foot
(A) GA-46				
(1) Table K-4 DNRC draft EIS	6557[1]	100	50[3]	131.15
(2) 21% return flows	6557	100	78.8	83.26
(3) Goroski estimated actual water use	6557	123	123[2]	53.31
(B) GA-201				
(1) Table K-4	2,440,552[1]	12249	6125[3]	398.49
(2) No return flows[4]	2,440,552	12249	12249	199.24
(3) Goroski actual water use	2,440,552	14508	14508[2]	168.22

---

[1] Based on original computer modeling by Dan Dodds.

[2] Personal communication, John Goroski. Water actually required by the project, both cases have no return flows.

[3] Assumes Table 3-1, DNRC 1991 and 50% flow or recharge to stream.

[4] Personal communication, Larry Cawlfield.

Exhibit 17 cont.

II. Correction for replacement power costs using Goroski actual flows.

Project/ scenario	DNRC net Benef. ($)	Annual power usage (GWhr)	Replace power cost ($)	Revised net benef. ($)	Ac/Ft water consume (AF)	Irr. value[1] per AF $/AF
(A) GA-46						
1) Repl. Pwr.@ 50 mills	6557	15.96	159.60	6397.40	123	52.01
2) Pwr. @ 100 mills	6557	15.96	957.60	5599.4	123	45.52
(B) GA-201						
1) Power @ 50 mills	2440552	15912.31	159123	2281429	14508	157.25
2) Power @ 100 mills	2440552	15912.31	954739	1485813	14508	102.41

---

[1] Ignoring indirect costs of foregone hydropower, recreation and water quality. eg. corresponds to column A of Table K-3.

III. Net benefits including recreation and hydropower losses at 50 mills and 100 mills.

	Irr. values ($/AF)	Recreation loss ($/AF)	Hydropower loss ($/AF)	Net Benefits
(A) GA-46				
1) Power @ 50 mills	52.01	50.37	69.16	-67.52
2) Power @ 100 mills	45.52	50.37	138.32	-143.17
(B) GA-201				
1) Power @ 50 mills	157.25	50.37	69.16	37.72
2) Power @ 100 mills	102.41	50.37	138.32	-86.28

EXHIBIT 18

Table 6-40. Recreational values of an acre-foot of flow on rivers and streams

Subbasin	July/August	Rest of Year
Headwaters	$35.40	$8.23
Upper Missouri	$19.46	$4.76
Middle Missouri and Marias/Teton	$ 5.81	$1.63

Source: Duffield et al. 1990

Table 6-41. Average flow reductions (acre-feet) from different alternatives

Alternative	Flow reductions during July and August	Flow reductions during the rest of year
Consumptive Use		
Headwaters Subbasin	38,850.9	11,189.1
Upper Missouri Subbasin	20,163.1	51,193.6
Marias/Teton Subbasin	29,691.5	16,210.5
Middle Missouri Subbasin	125,897.0	89,993.0
Instream		
Headwaters Subbasin	0.0	121.0
Upper Missouri Subbasin	7,991.5	7,755.0
Marias/Teton Subbasin	2,397.5	1,554.7
Middle Missouri Subbasin	13,462.6	10,504.0
Combination		
Headwaters Subbasin	18,933.7	5,123.6
Upper Missouri Subbasin	20,470.5	20,743.2
Marias/Teton Subbasin	7,745.6	6,950.1
Middle Missouri Subbasin	51,084.1	35,983.0

Table 6-42. Reductions in annual value of recreation due to change in average flows

Alternative/ Subbasin	Flow reductions during July and August	Flow reductions during rest of year	Total
Consumptive Use			
Headwaters	$1,400,000	$92,000	$1,492,000
Upper Missouri	$390,000	$240,000	$630,000
Marias/Teton	$170,000	$26,000	$196,000
Middle Missouri	$730,000	$150,000	$880,000
Total			$3,198,000
Instream			
Headwaters	$0	$1,000	$1,000
Upper Missouri	$160,000	$37,000	$197,000
Marias/Teton	$14,000	$3,000	$17,000
Middle Missouri	$78,000	$17,000	$95,000
Total			$310,000
Combination			
Headwaters	$670,000	$42,000	$712,000
Upper Missouri	$400,000	$99,000	$499,000
Marias/Teton	$45,000	$6,000	$51,000
Middle Missouri	$300,000	$59,000	$359,000
Total			$1,621,000

EXHIBIT 19

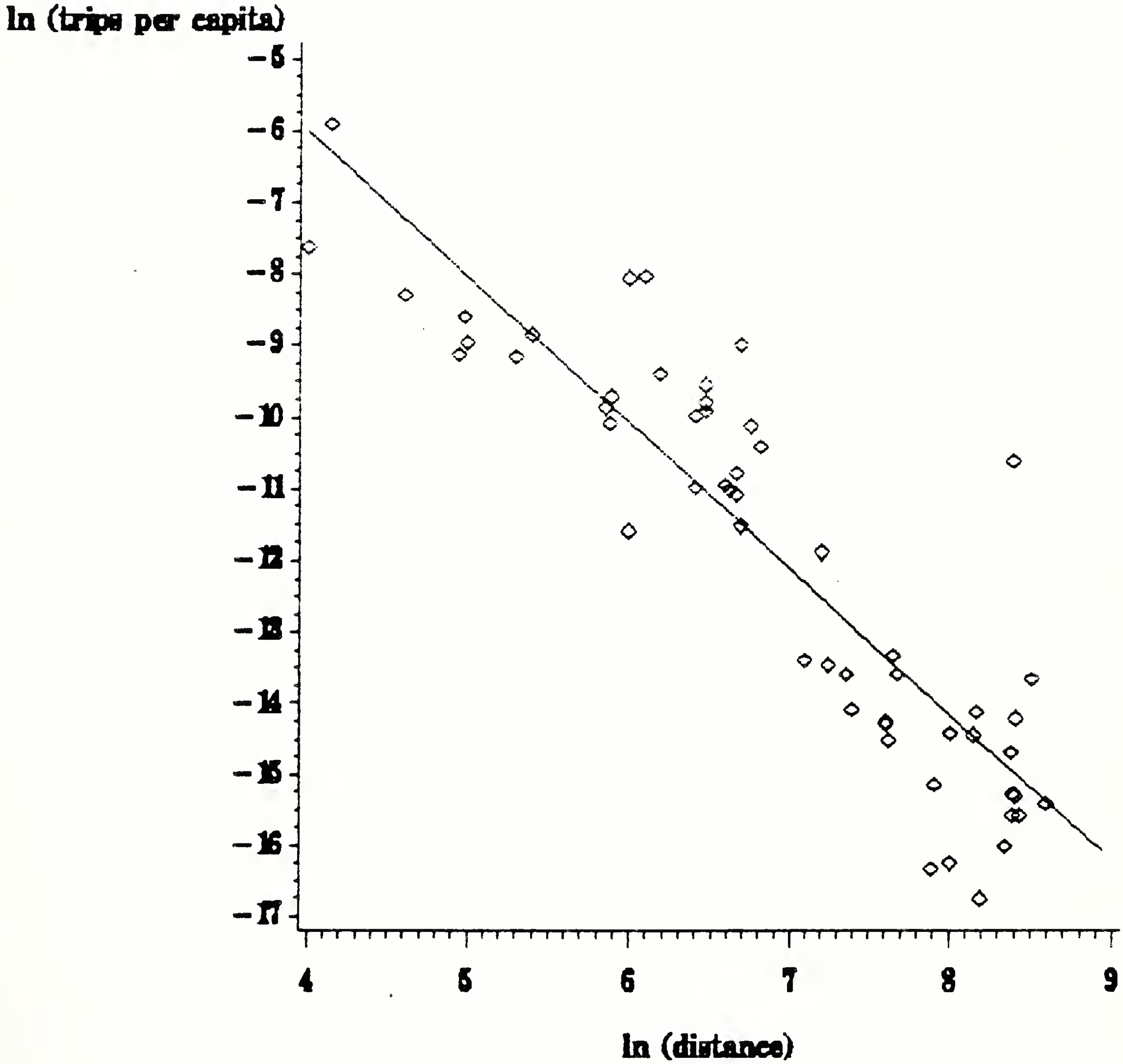
Table 1. Recreation and wildlife related economic valuation studies available for Forest Service RPA review by year.

Year	Total studies	Number of specific estimates		
		Total	Big game	trout fishing
1978	15	34	7	5
1982	36	95	15	15
1988	120	287	56	40

Source: Derived from Dwyer (1978), Loomis and Sorg (1982) and Walsh, Johnson and McKean (1988).

Plot of visitation vs. distance in a Travel Cost Model demand relationship of the Madison River

EXHIBIT 20



ource: Duffield, Loomis and Brooks 1987.

EXHIBIT 21

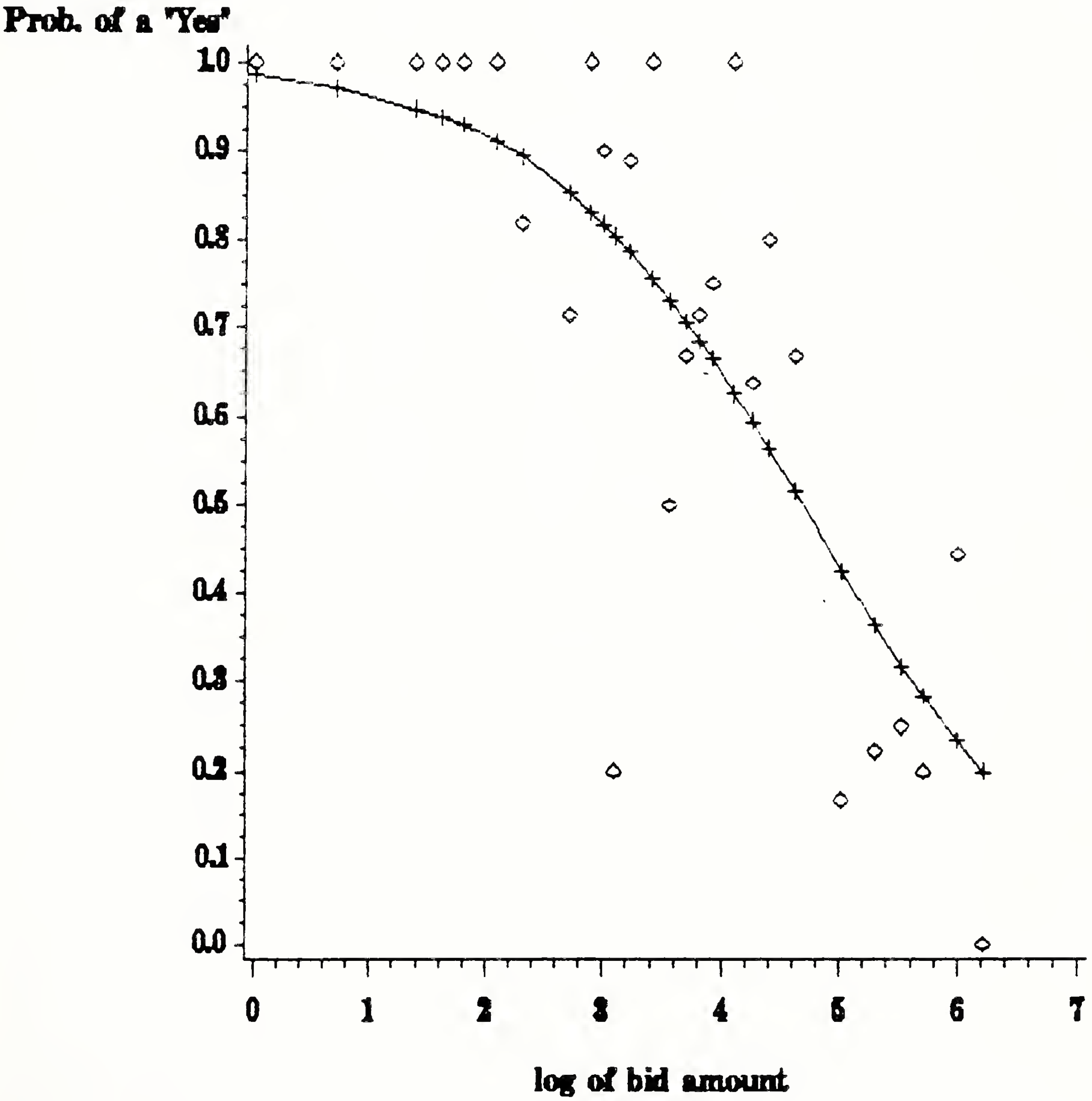
Table 1. Summary of response to dichotomous choice valuation question for the most recent trip: Missouri and Madison Rivers.

Dollar bid	Missouri River		Madison River	
range	yes/sample	ratio yes	yes/sample	ratio yes
1-5	24/26	.92	17/17	1.00
6-15	22/25	.88	18/22	.82
18-30	14/32	.44	23/29	.79
35-50	7/30	.23	22/32	.69
70-100	3/16	.19	15/22	.68
150-500	1/27	.03	5/24	.25

Notes: Derived from Duffield and Allen, 1988. Missouri River is Holter to Cascade segment; Madison River is mainstem.

Plot of actual and predicted probabilities of a "yes" response to varying bid amounts; Madison River

EXHIBIT 22



ource: Duffield and Allen 1988.

EXHIBIT 23

Table 2. Estimated value/trip for major cold water stream fisheries in Montana.

River	Dollar value/trip		Ratio	Sample size	
	TCM	CVM	TCM/CVM	TCM	CVM
Madison	234	228	1.03	357	148
Upper Yellowstone	230	150	1.53	81	121
Boulder	180	149	1.21	57	69
Rock Creek	173	92	1.88	89	78
Big Hole	164	218	.75	187	140
Gallatin	161	180	.89	264	152
E. Gallatin	143			37	
Blackfoot	142	133	1.07	149	97
Bighorn	121	159	.60	160	151
Beaverhead	112	188	.59	120	108
Smith	94	153	.61	43	44
Stillwater	82	85	.96	133	113
Bitterroot	73	59	1.24	88	117
Middle Clark Fork	68	86	.79	231	126
Middle Yellowstone	63	74	.85	174	105
Swan	61			26	
Missouri Holter-C.	60	63	.95	357	148
Upper Flathead	56	99	.57	66	65
Kootenai	56	38	1.47	121	72
Upper Clark Fork	51			94	

Notes: Derived from Duffield and Allen, 1988. Underline denotes major Clark Fork Basin water. TCM (travel cost model) is in 1985 dollars CVM (contingent valuation) is in 1986 dollars. River segments are mainstems except: U. Clark Fork is Bitterroot R. to Warm Springs Cr.; M. Clark Fork is Bitterroot R. to Segal Cr.; U. Flathead is Flathead Lake to South Fork; Missouri is Holter to Cascade; U. Yellowstone is Springdale to Gardner; M. Yellowstone is Springdale to Huntley.

EXHIBIT 24

Table 3. Correlation of value per trip estimates for two nonmarket valuation methods (travel cost and contingent valuation) for Montana rivers.

Sample	Correlation coefficient Pearson	 Spearman
A. Complete sample (17 rivers):		
	.7253	.7132
	p = .000	p = .001
B. Subsample excluding sites with less than 80 observations (sample of 12 rivers):		
	.7993	.8112
	p = .001	p = .001

Notes: Derived from Duffield and Allen, 1988.

EXHIBIT 25

Table 37
Average Net Economic Values Per Trip
Calculated From Bivariate Logit Models in Table 31

Model	Truncated Mean[*] (Std. Error)	Median (Std. Error)
RESIDENTS		
Upper Subbasin		
Rivers	$ 146.55 (13.55)	$ 59.58 (9.72)
Reservoirs[**]	$ 143.23 (9.46)	$ 49.48 (6.83)
Middle Subbasin		
Rivers	$ 175.19 (27.45)	$ 84.58 (26.42)
Reservoirs	$ 134.62 (10.30)	$ 43.62 (7.49)
Lower Subbasin		
Rivers	$ 142.65 (18.88)	$ 65.92 (12.95)
Reservoirs	$ 163.78 (19.56)	$ 67.03 (16.66)
NONRESIDENTS		
Rivers	$ 792.52 (85.39)	$ 506.19 (103.98)
Reservoirs	$ 507.14 (111.59)	$ 178.89 (69.25)

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[*] Truncation point is $500 for residents and $ 2000 for nonresidents.

[**] Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

Table 38
Average Net Economic Values Per Day
Current Trip Question

Model	Based on Truncated Mean[*]	Std. Err.
RESIDENTS		
Upper Subbasin		
Rivers	$ 52.53	$ 9.77
Reservoirs[**]	$ 39.90	$ 10.23
Middle Subbasin		
Rivers	$ 60.20	$ 14.15
Reservoirs	$ 49.68	$ 5.95
Lower Subbasin		
Rivers	$ 65.73	$ 10.60
Reservoirs	$ 40.24	$ 7.95
NONRESIDENTS		
Rivers	$ 193.30	$ 23.70
Reservoirs	$ 128.72	$ 33.37

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[*] Truncation point is $500 for residents, $2000 for nonresidents.

[**] Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

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Table 4-41. Recreation expenditures per day

Subbasin	Activity	Rivers	Reservoirs
Headwaters	Shore fishing	$25.13	$38.55
	Boat fishing	$43.06	$44.84
	Boating/floating	$42.36	$82.50
	Shoreline[a]	$32.17	$27.57
Upper Missouri	Shore fishing	$75.49	$33.64
	Boat fishing	$85.34	$38.68
	Boating/floating	$44.45	$55.05
	Shoreline[a]	$37.44	$30.67
Middle Missouri and Marias/Teton	Shore fishing	$41.76	$57.26
	Boat fishing	$27.44	$33.63
	Boating/floating	$41.55	$41.28
	Shoreline[a]	$29.66	$48.48

[a] Picnicking, camping, swimming, sightseeing, etc.

Source: Duffield et al. 1990

Note: Subbasin boundaries used in the survey differed slightly from those in this EIS.

Table 4-40. Total recreation use days in 1989

Subbasin	Residents	Nonresidents
	(thousands of use days)	
Headwaters		
Rivers	349 to 478	136 to 220
Reservoirs	49 to 115	33 to 70
Upper Missouri		
Rivers	299 to 521	12 to 21
Reservoirs	278 to 456	7 to 16
Middle Missouri and Marias/Teton		
Rivers	165 to 312	3 to 16
Reservoirs	194 to 366	2 to 8
All subbasins[a]		
Rivers	949 to 1,191	163 to 250
Reservoirs	608 to 860	50 to 94

[a] The range of results for all subbasins is smaller than for individual subbasins due to a larger sample size.

Source: Duffield et al. 1990

NOTE: Subbasin boundaries used in the survey differed slightly from those in this EIS.

Table 4-42. Total annual recreation expenditures

Subbasin	Residents	Nonresidents
	(millions of dollars)	
Headwaters	12.1 to 23.9	27.9 to 48.2
Upper Missouri	23.0 to 38.1	2.4 to 6.0
Middle Missouri and Marias/Teton	14.4 to 27.3	3.0 to 6.0
All subbasins[a]	57.9 to 81.0	33.7 to 54.5

[a] The range of results for all subbasins is smaller than for individual subbasins due to a larger sample size.

Source: Duffield et al. 1990

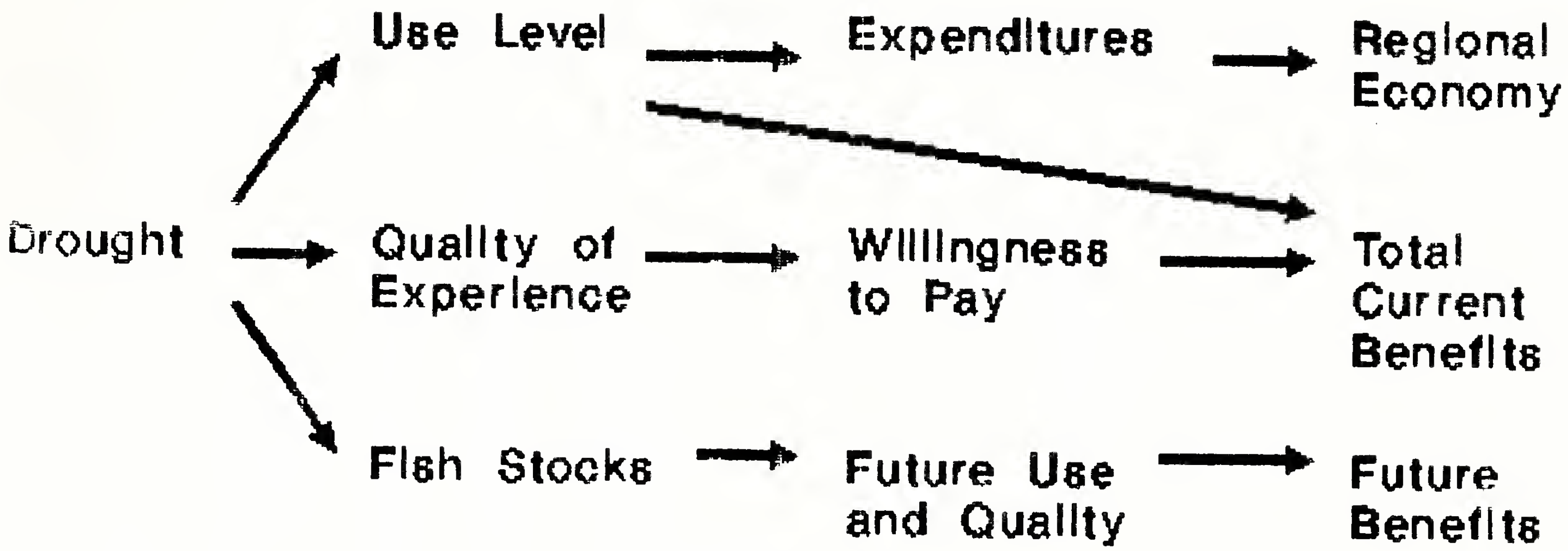
Table 4-43. Total net economic value of recreation trips

Subbasin	Residents (millions of dollars)
Headwaters	
Rivers	13.1 to 30.4
Reservoirs	1.1 to 5.3
Upper Missouri	
Rivers	11.4 to 38.0
Reservoirs	12.0 to 24.4
Middle Missouri and Marias/Teton	
Rivers	8.7 to 22.7
Reservoirs	5.6 to 16.8
All subbasins[a]	75.4 to 114.1
	Nonresidents
All subbasins[a]	35.3 to 63.2
Rivers	27.2 to 52.8
Reservoirs	3.7 to 14.8

[a] The range of results for all subbasins is smaller than for individual subbasins due to a larger sample size.

Source: Duffield et al. 1990

Impacts of Drought on Recreation



Drought

Use Level

Quality of Experience

Fish Stocks

Expenditures

Willingness to Pay

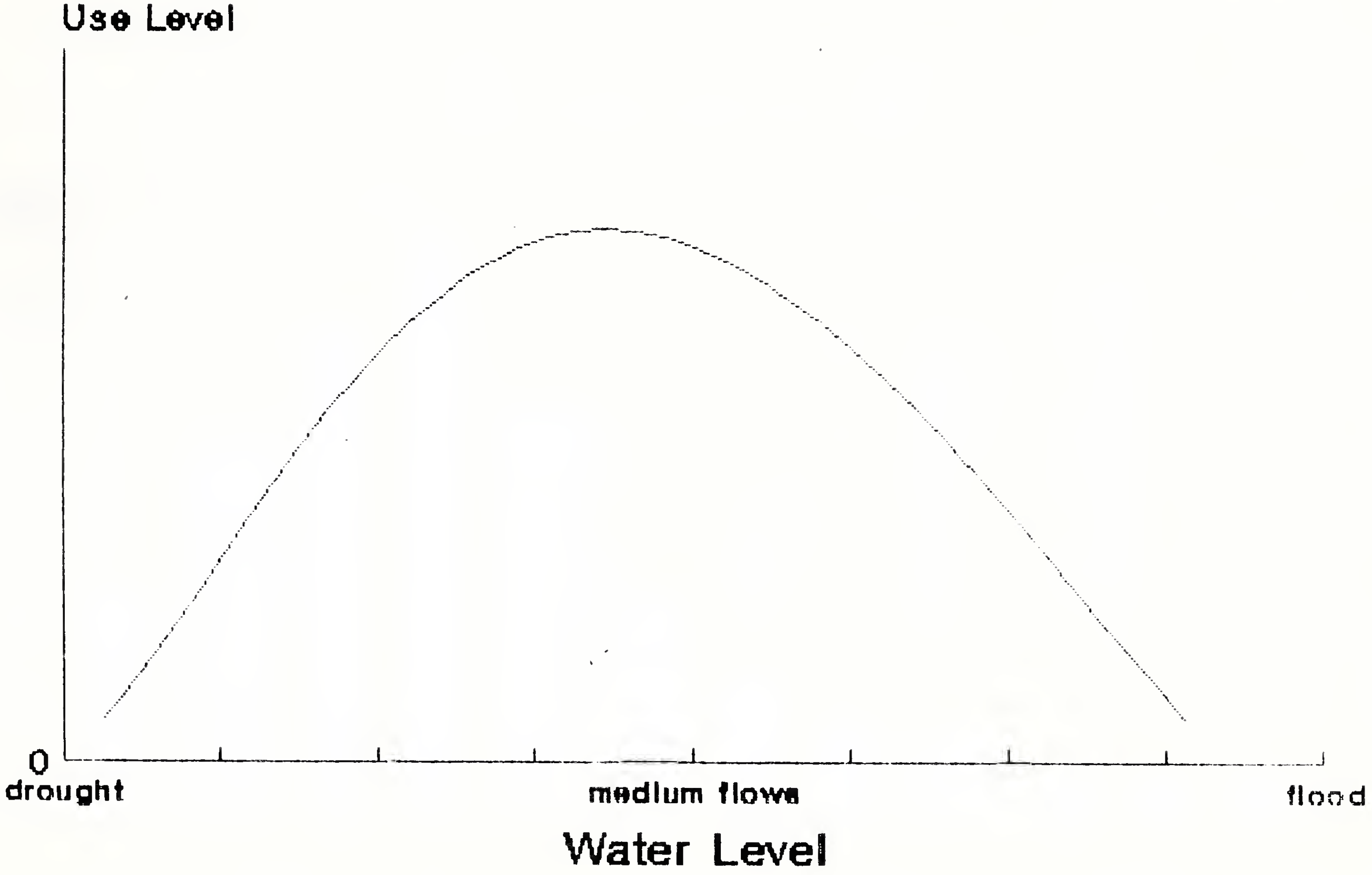
Future Use and Quality

Regional Economy

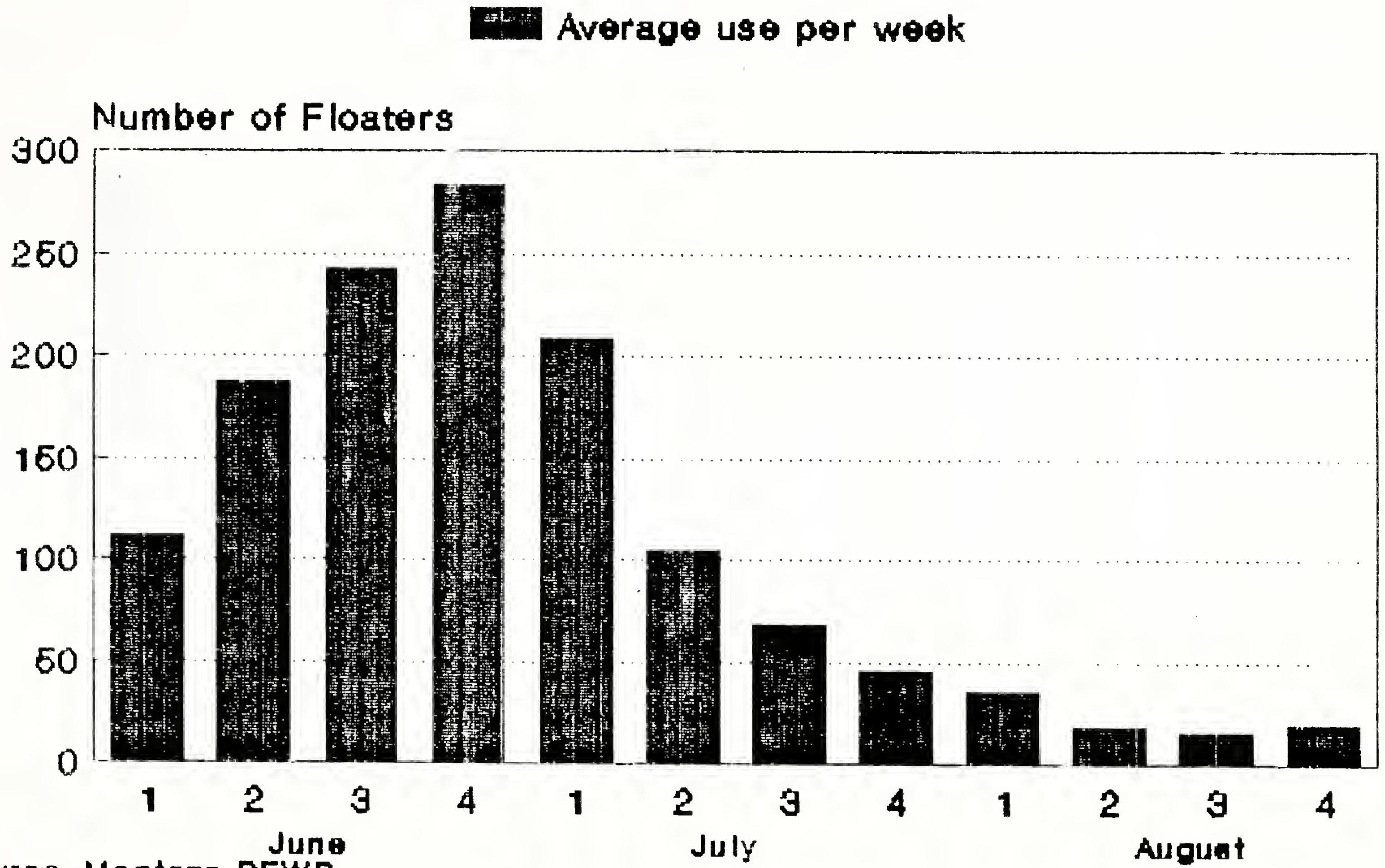
Total Current Benefits

Future Benefits

Variation of Use With Flow Level



Number of Floaters Using the Smith River
(Average of 1984, 1986, and 1987)



Source: Montana DFWP.

Length of Float Season vs. Use

Smith River 1984-1990

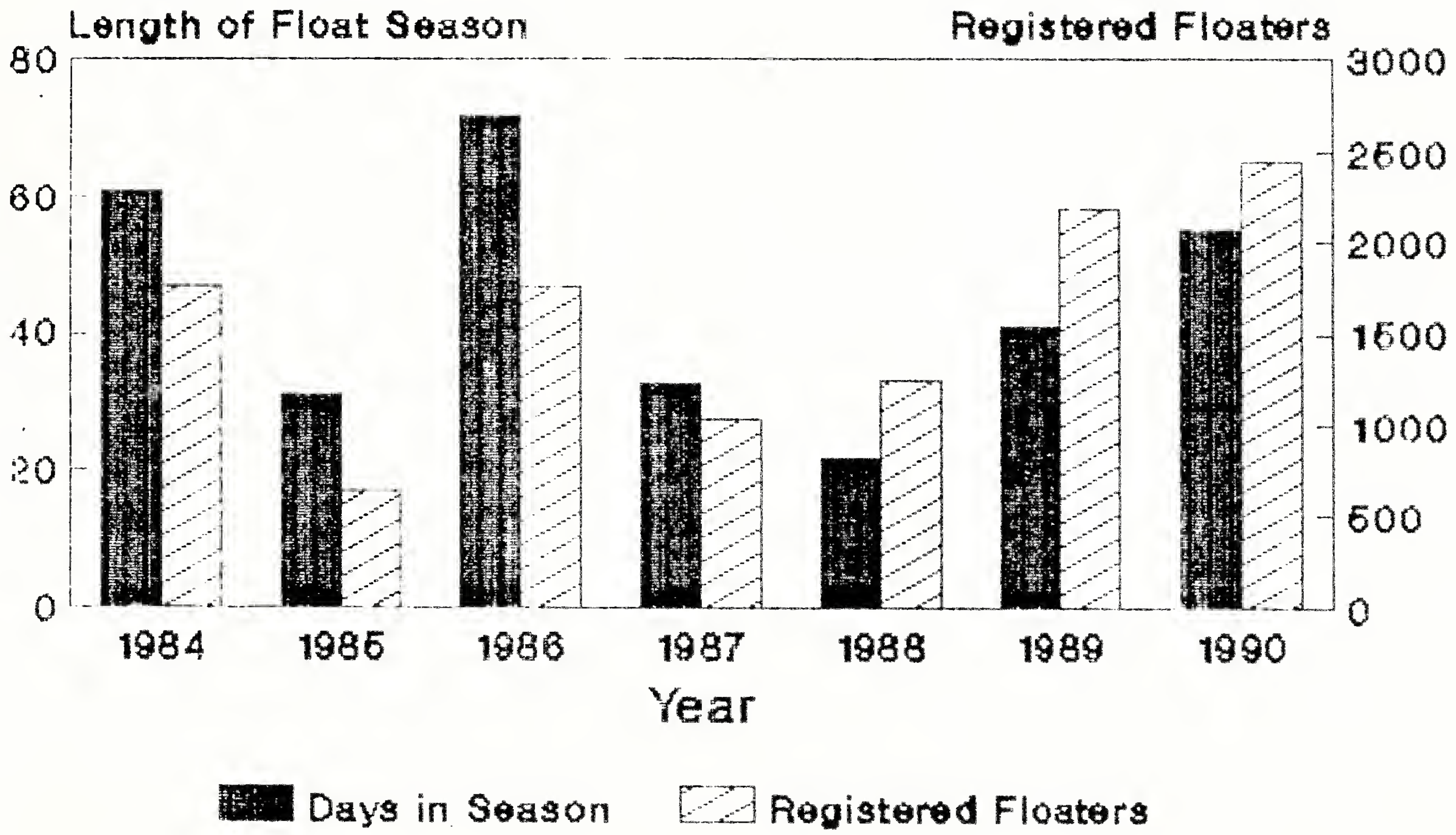


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Figure 3
Predicted vs. Actual Resident Responses

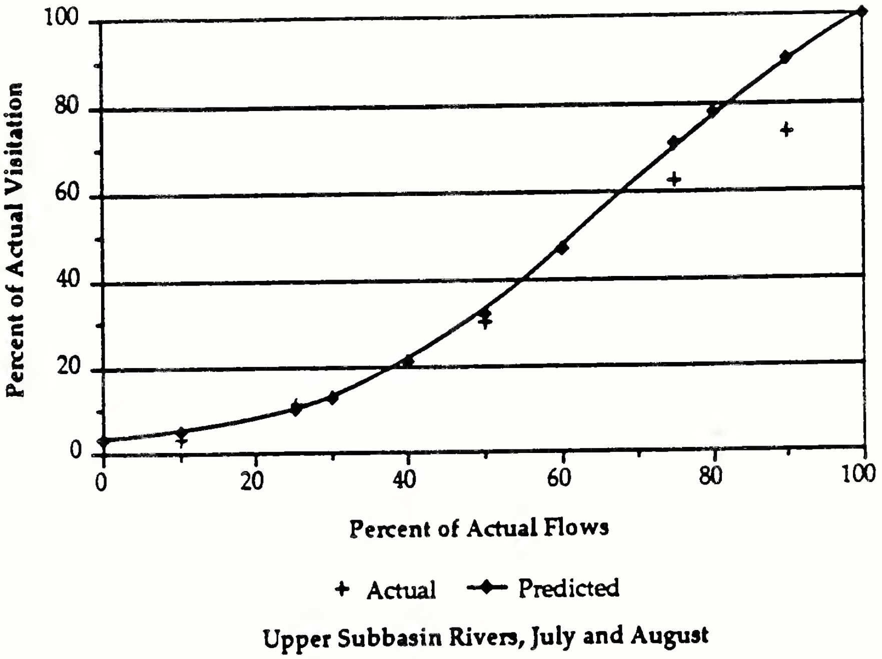

Figure 4
Marginal Instream Flow Valuation

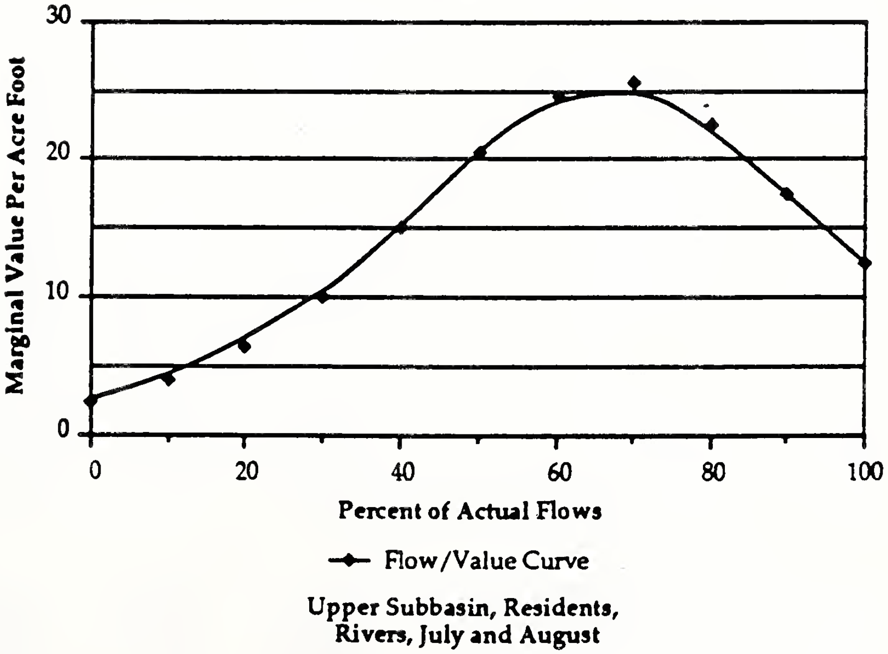

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Table 44
Marginal Values Per Acre Foot of Flow
Rivers and Streams
Total For Resident and Nonresident Use

Model	July and August 50% (SE)	 75% (SE)	 100% (SE)	Rest of Year 50% (SE)	 75% (SE)	 100% (SE)
Upper Subbasin	50.28	67.98	35.40	17.88	22.98	8.23
	(6.39)	(8.67)	(4.52)	(2.28)	(2.94)	(1.05)
Middle Subbasin	28.05	26.83	19.46	5.58	8.50	4.76
	(7.04)	(6.41)	(2.43)	(1.33)	(2.03)	(1.19)
Lower Subbasin	9.46	10.63	5.81	3.60	4.21	1.63
	(1.92)	(2.09)	(1.15)	(.74)	(.83)	(.32)

Table 6-40. Recreational values of an acre-foot of flow on rivers and streams

Subbasin	July/August	Rest of Year
Headwaters	$35.40	$8.23
Upper Missouri	$19.46	$4.76
Middle Missouri and Marias/Teton	$ 5.81	$1.63

Source: Duffield et al. 1990

Table 6-41. Average flow reductions (acre-feet) from different alternatives

Alternative	Flow reductions during July and August	Flow reductions during the rest of year
Consumptive Use		
Headwaters Subbasin	38,850.9	11,189.1
Upper Missouri Subbasin	20,163.1	51,193.6
Marias/Teton Subbasin	29,691.5	16,210.5
Middle Missouri Subbasin	125,897.0	89,993.0
Instream		
Headwaters Subbasin	0.0	121.0
Upper Missouri Subbasin	7,991.5	7,755.0
Marias/Teton Subbasin	2,397.5	1,554.7
Middle Missouri Subbasin	13,462.6	10,504.0
Combination		
Headwaters Subbasin	18,933.7	5,123.6
Upper Missouri Subbasin	20,470.5	20,743.2
Marias/Teton Subbasin	7,745.6	6,950.1
Middle Missouri Subbasin	51,084.1	35,983.0

Table 6-42. Reductions in annual value of recreation due to change in average flows

Alternative/ Subbasin	Flow reductions during July and August	Flow reductions during rest of year	Total
Consumptive Use			
Headwaters	$1,400,000	$92,000	$1,492,000
Upper Missouri	$390,000	$240,000	$630,000
Marias/Teton	$170,000	$26,000	$196,000
Middle Missouri	$730,000	$150,000	$880,000
Total			$3,198,000
Instream			
Headwaters	$0	$1,000	$1,000
Upper Missouri	$160,000	$37,000	$197,000
Marias/Teton	$14,000	$3,000	$17,000
Middle Missouri	$78,000	$17,000	$95,000
Total			$310,000
Combination			
Headwaters	$670,000	$42,000	$712, 000
Upper Missouri	$400,000	$99,000	$499,000
Marias/Teton	$45,000	$6,000	$51,000
Middle Missouri	$300,000	$59,000	$359,000
Total			$1,621,000

Exhibit 33. Summary findings: public interest criteria.

(A) DFWP cases with competing uses.

	Efficient allocation of consumptive use projects at 75 mill power.	
	Pass benefit/cost	Do not pass
(1) Municipal	21	0
Number of Acre/Feet	34,659	0
Benefits (millions $)	452.12	
Costs		
Replacement power	--	
Hydropower	-63.55	
Recreation	-8.94	
Fish and wildlife	--	
Water quality	--	
Net benefits	379.63	
(2) Irrigation projects	2	218
Number of Acre/Feet	10,650	79,631
Benefits	17.25	126.29
Costs		
Replacement power	-0.94	-120.71
Hydropower	-6.71	-505.26
Recreation	-0.60	-105.01
Fish and wildlife	--	--
Water quality	--	--
Net benefits		-604.69
(B) DFWP cases with no competing uses		
DFWP reaches (number)	333	
Number of Acre/Feet	9,862,968	
Benefits (millions $)		
Recreation	697.34	
Hydropower	+	
Water quality	+	
Fish and wildlife	+	
Costs-Administrative	-	
	697.34	

Exhibit 33 continued.

(C) Summary findings for DFWP reservation at 75 mill power: Reservation requests in the public interest.

	Efficient # of Reservations	Efficient Acre/feet	% of total A/F requested	Net Benefits (Millions $)
(1) DFWP				
(a) Cases with competing uses	50	379,631	89.3%	604.69
(b) Cases with no competing uses	333	9,862,968	100%	697.34
(c) Total				1302.03
(2) Municipal				
(a) Cases with competing uses	21	34,659	100%	379.63
(3) Conservation districts				
(a) Cases with competing uses	2	10,650	2.7%	17.25
Net benefits to efficient allocation		10,287,908		1698.91